1985-1988

MERKUR XR4Ti

LOOSE LEAF
SHOP MANUAL

Ford parts and Service Division
Training and Publicatios Department

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1988
ADDENDUM

MERKUR XR4Ti
SHOP MANUAL UPDATE

1988 MERKUR XR4Ti SHOP MANUAL UPDATE

ASSEMBLY INSTRUCTIONS

AUGUST 1987

This package contains the new and revised pages needed to update the Merkur XR4Ti Shop Manual. When this supplement is incorporated, the Shop Manual will contain the latest service and diagnostic information for the 1985 through 1988 XR4Ti models.

If this supplement is to be used to update an already assembled Shop Manual, simply replace the old pages with the new ones. If it is to be used to update a new Shop Manual, begin by assembling the first edition (including all previous updates) then insert this update.

The following history of the Merkur XR4Ti Shop Manual is provided to ensure that you have a complete, up-to-date Shop Manual.

- The Merkur XR4Ti Shop Manual was originally published in January 1985.
- The first update to the Shop Manual was released in mid-1985. These pages are not dated but the notation "SUPPLEMENT 1" appears in the lower corner of the corrected pages.
- Speed control (Group 37) with a new tab was added in late 1985.
- The second update was released in mid-1986. These pages are dated 8/86 in the lower corner. This release included a new tab and all pages for Group H - Engine/Emission Diagnosis to be located at the back of the manual.
- The third update was released in January 1987. These pages are dated 1/87 in the lower corner. This package was made up of Group 13 - Steering System updates.
- This, the fourth update, was released in August 1987. These pages are dated 8/87 in the lower corner.

The following chart can be used as a checklist to ensure proper assembly of the Shop Manual.

DISCARD THE PAGES REMOVED FROM THE SHOP MANUAL.

SECTION	REMOVE	INSERT
10-01	10-01-1	10-01-1
	10-01-3	10-01-3
	10-01-5	10-01-5
	10-01-7	10-01-7
11-01	11-01-1	11-01-1
	11-01-7	11-01-7
11-17	11-17-1	11-17-1
	11-17-3	11-17-3
11-00(Specifications)	11-00-1	11-00-1
12-01	12-01-17	12-01-17
	12-01-19	12-01-19
	12-01-21	12-01-21
12-20	12-20-11	12-20-11
12-70	12-70-1	12-70-1
	12-70-3	12-70-3
	12-70-5	12-70-5
	12-70-7	12-70-7
13-INDEX	Group 13 Index Page	Group 13 Index Page
13-46	13-46-1	13-46-1
	13-46-7	13-46-7
	13-46-9	13-46-9
13-48	13-48-1	13-48-1
	13-48-5	13-48-5
	13-48-9	13-48-9
	13-48-17	13-48-17
13-55	13-55-3	13-55-3
	13-55-5	13-55-5
14-01	14-01-7	14-01-7
14-10	14-10-3	14-10-3
	14-10-7	14-10-7
14-32	14-32-3	14-32-3
	14-32-5	14-32-5
	14-32-9	14-32-9
	14-32-11	14-32-11
	14-32-13	14-32-13
14-00 (Specifications)	14-00-1	14-00-1
15-01	15-01-9	15-01-9
15-03	15-03-3	15-03-3
	15-03-5	15-03-5
	15-03-23	15-03-23
15-00 (Specifications)	15-00-1	15-00-1

OVER PLEASE

SECTION	REMOVE	INSERT
16-33	16-33-1	16-33-1
	16-33-15	16-33-15
	16-33-17	16-33-17
	16-33-19	16-33-19
	16-33-21	16-33-21
	16-33-37	16-33-37
	16-33-39	16-33-39
	16-33-41	16-33-41
	16-33-45	16-33-45
21-01	21-01-11	21-01-11
	21-01-13	21-01-13
21-05	21-05-5	21-05-5
	21-05-23	21-05-23
	21-05-31	21-05-31
	21-05-43	21-05-43
	21-05-61	21-05-61
21-29	21-29-1	21-29-1
	21-29-5	21-29-5
21-00 (Specifications)	21-00-1	21-00-1
23-01	23-01-7	23-01-7
	23-01-13	23-01-13
23-00 (Specifications)	23-00-1	23-00-1
24-01	Entire Section	Entire Section
24-29	24-29-9	24-29-9
27-01	27-01-7	27-01-7
27-02	27-02-5	27-02-5
27-03	27-03-1	27-03-1
33-50	33-50-1	33-50-1
33-92	33-92-7	33-92-7
34-30	34-30-1	34-30-1
35-03	35-03-1	35-03-1
	35-03-3	35-03-3
35-21	35-21-9	35-21-9
35-70	35-70-1	35-70-1
36-01	Entire Section	Entire Section
43-11	43-11-1	43-11-1
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	44-41-3	44-41-3
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47-10	47-10-1	47-10-1
	47-10-7	47-10-7
	47-10-9	47-10-9
50-04	50-04-1	50-04-1
Group H	Entire Group - Sections 1 thru 4	Entire Group - Sections 1 thru 4

IMPORTANT SAFETY NOTICE

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all motor vehicles as well as the personal safety of the individual doing the work. This Shop Manual provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help ensure reliability.

There are numerous variations in procedures, techniques, tools, and parts for servicing vehicles, as well as in the skill of the individual doing the work. This manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in this manual must first establish that he compromises neither his personal safety nor the vehicle integrity by his choice of methods, tools, or parts.

NOTES, CAUTIONS, AND WARNINGS

As you read through the procedures, you will come across NOTES, CAUTIONS, and WARNINGS. Each one is there for a specific purpose. NOTES give you added information that will help you to complete a particular procedure. CAUTIONS are given to prevent you from making an error that could damage the vehicle. WARNINGS remind you to be especially careful in those areas where carelessness can cause personal injury. The following list contains some general WARNINGS that you should follow when you work on a vehicle.

- Always wear safety glasses for eye protection.
- Use safety stands whenever a procedure requires you to be under the vehicle.
- Be sure that the ignition switch is always in the OFF position, unless otherwise required by the procedure.
- Set the parking brake when working on the vehicle. If you have an automatic transmission, set it in PARK. If you have a manual transmission, it should be in REVERSE. Place wood blocks of a 4″ × 4″ size or larger to the front and rear surfaces of the tires to provide further restraint from inadvertent vehicle movement.
- Operate the engine only in a well-ventilated area to avoid the danger of carbon monoxide.
- Keep yourself and your clothing away from moving parts when the engine is running, especially the fan and belts.
- To prevent serious burns, avoid contact with hot metal parts such as the radiator, exhaust manifold, tail pipe, catalytic converter, and muffler.
- Do not smoke while working on the vehicle.
- To avoid injury, always remove rings, watches, loose hanging jewelry, and loose clothing before beginning to work on a vehicle.
- Keep hands and other objects clear of the radiator fan blades. The electric cooling fan on the 2.3 turbocharged engine is mounted behind the radiator and can start to operate at any time by an increase in underhood temperature, even though the ignition switch may be off. For this reason, care should be taken to ensure that the electric cooling fan is completely disconnected when working under the hood.

FOREWORD

The Merkur XR4Ti Shop Manual provides information covering normal services, repairs, and maintenance for Body, Chassis, and Electrical systems manufactured in West Germany.

This shop manual is organized into Groups covering general systems. The basic part numbers for components covered in the Group are included in parenthesis after the Group Number. For example:

Brakes	**Group 12**	**(2000)**
General System Covered in Group	Group Number	Basic Part Number for Brake System Components

Some component parts may not have the same basic part number. In these cases, more than one basic part number will appear with the Group Number. For example:

Suspension	**Group 14**	**(3000)**	**&**	**(5000)**
General System Covered in Group Part Only	Group Number	Basic Part for Suspension Components		Exhaust Basic Number

Within each Group, the information is further divided into Sections. There is one Section for each component or subsystem. Some Groups contain a Service Section to cover procedures common to several components or subsystems within the Group. In general, each Section contains the Description, Operation, Diagnosis and Testing, Removal and Installation, and Disassembly and Assembly procedures for the components covered in the Section. Diagnostic and Troubleshooting Charts are also included in some Sections to help you systematically locate and correct problems.

To aid in locating specific subjects in this manual, use the Tab Guides or the Alphabetical Subject Index in the back of this manual.

As a further aid, the first page of each group includes a Contents page to locate service operations covered in that group. This Group-Section breakdown is also indicated in the page number located at the top of each page.

Example 11-02-03 = (Group) 11 — (Section) 02 — (Page) 3

The descriptions and specifications contained in this manual were in effect at the time this manual was approved for printing. Ford Motor Company reserves the right to discontinue models at any time, and change specifications or design without notice and without incurring obligation.

For information on ordering Special Service Tools, refer to the last page of this manual.

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Training and Publication Department

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METRICS

INTRODUCTION

Most threaded fasteners are covered by specifications that define required mechanical properties, such as tensile strength, yield strength, proof load and hardness. These specifications are carefully considered in initial selection of fasteners for a given application. To assure continued satisfactory vehicle performance, replacement fasteners used should be of the correct strength, as well as the correct nominal diameter, thread pitch, length, and finish.

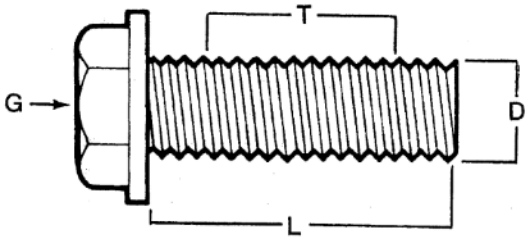
Most original equipment fasteners (English system or Metric) are identified with markings or numbers indicating the strength of the fastener. These markings are described in the pages that follow. Attention to these markings is important in assuring that the proper replacement fasteners are used.

Further, some metric fasteners, especially nuts, are colored blue. This metric blue identification is in most cases a temporary aid for production start-up, and color will generally revert to normal black or bright after start-up.

English system and metric system fasteners are available through your Ford Parts and Service operation.

NOMENCLATURE FOR BOLTS

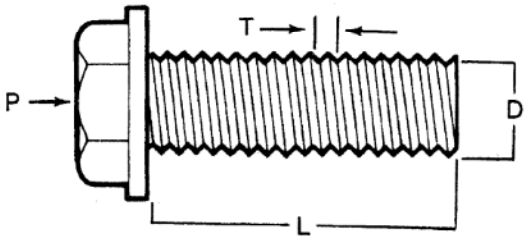
(ENGLISH) INCH SYSTEM
Bolt, ½-13 x 1



G—Grade Marking (bolt strength)
L—Length, (inches)**
T—Thread Pitch (thread/inch)
D—Nominal Diameter (inches)



METRIC SYSTEM
Bolt M12-1.75 x 25



P—Property Class* (bolt strength)
L—Length (millimeters)**
T—Thread Pitch (thread width crest to crest mm)
D—Nominal Diameter (millimeters)



*The property class is an Arabic numeral distinguishable from the slash SAE English grade system.
**The length of all bolts is measured from the underside of the head to the end.

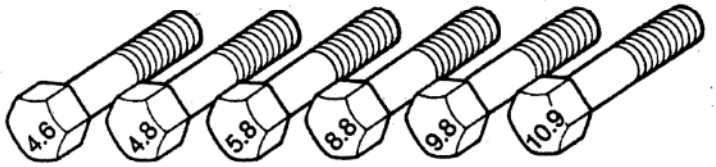
BOLT STRENGTH IDENTIFICATION

(ENGLISH) INCH SYSTEM



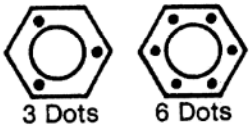
English (Inch) bolts—Identification marks correspond to bolt strength—increasing number of slashes represent increasing strength.

METRIC SYSTEM



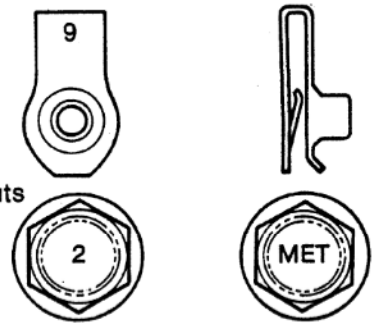
Metric bolts—Identification class numbers correspond to bolt strength—increasing numbers represent increasing strength. Common metric fastener bolt strength property are 9.8 and 10.9 with the class identification embossed on the bolt head.

HEX NUT STRENGTH IDENTIFICATION

(ENGLISH) INCH SYSTEM			METRIC SYSTEM		
Grade	Hex Nut Grade 5	Hex Nut Grade 8	**Class**	Hex Nut Property Class 9	Hex Nut Property Class 10
Identification	 3 Dots	6 Dots	**Identification**	 Arabic 9	 Arabic 10
Increasing dots represent increasing strength.			May also have blue finish or paint daub on hex flat. Increasing numbers represent increasing strength.		

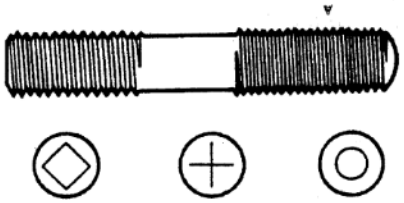
OTHER TYPES OF PARTS

Metric identification schemes vary by type of part, most often a variation of that used of bolts and nuts. Note that many types of English and metric fasteners carry no special identification if they are otherwise unique.



—Stamped U-Nuts

—Tapping, thread forming and certain other case hardened screws



—Studs, Large studs may carry the property class number. Smaller studs use a geometric code on the end.

ENGLISH METRIC CONVERSION

Description	Multiply	By	For Metric Equivalent
ACCELERATION	Foot/sec²	0.304 8	metre/sec² (m/s²)
	Inch/sec²	0.025 4	metre/sec²
TORQUE	Pound-inch	0.112 98	newton-metres (N·m)
	Pound-foot	1.355 8	newton-metres
POWER	horsepower	0.746	kilowatts (kw)
PRESSURE or STRESS	inches of water	0.2488	kilopascals (kPa)
	pounds/sq. in.	6.895	kilopascals (kPa)
ENERGY or WORK	BTU	1 055.	joules (J)
	foot-pound	1.355 8	joules (J)
	kilowatt-hour	3 600 000. or 3.6×10^6	joules (J = one W's)
LIGHT	foot candle	10.76	lumens/metre² (lm/m²)
FUEL PERFORMANCE	miles/gal	0.425 1	kilometres/litre (km/l)
	gal/mile	2.352 7	litres/kilometre (l/km)
VELOCITY	miles/hour	1.609 3	kilometres/hr. (km/h)
LENGTH	inch	25.4	millimetres (mm)
	foot	0.304 8	metres (m)
	yard	0.914 4	metres (m)
	mile	1.609	kilometres (km)
AREA	inch²	645.2	millimetres² (mm²)
		6.45	centimetres² (cm²)
	foot²	0.092 9	metres² (m²)
	yard²	0.836 1	metres²
VOLUME	inch³	16 387.	mm³
	inch³	16.387	cm³
	quart	0.016 4	litres (1)
	quart	0.946 4	litres
	gallon	3.785 4	litres
	yard³	0.764 6	metres³ (m³)
MASS	pound	0.453 6	kilograms (kg)
	ton	907.18	kilograms (kg)
	ton	0.90718	tonne
FORCE	kilogram	9.807	newtons (N)
	ounce	0.278 0	newtons
	pound	4.448	newtons
TEMPERATURE	degree farenheit	0.556 (°F −32)	degree Celsius (°C)

DECIMAL AND METRIC EQUIVALENTS

Fractions	Decimal Inch	Metric mm
1/64	.015625	.397
1/32	.03125	.794
3/64	.046875	1.191
1/16	.0625	1.588
5/64	.078125	1.984
3/32	.09375	2.381
7/64	.109375	2.778
1/8	.125	3.175
9/64	.140625	3.572
5/32	.15625	3.969
11/64	.171875	4.366
3/16	.1875	4.763
13/64	.203125	5.159
7/32	.21875	5.556
15/64	.234375	5.953
1/4	.250	6.35
17/64	.265625	6.747
9/32	.28125	7.144
19/64	.296875	7.54
5/16	.3125	7.938
21/64	.328125	8.334
11/32	.34375	8.731
23/64	.359375	9.128
3/8	.375	9.525
25/64	.390625	9.922
13/32	.40625	10.319
27/64	.421875	10.716
7/16	.4375	11.113
29/64	.453125	11.509
15/32	.46875	11.906
31/64	.484375	12.303
1/2	.500	12.7

Fractions	Decimal Inch	Metric mm
33/64	.515625	13.097
17/32	.53125	13.494
35/64	.546875	13.891
9/16	.5625	14.288
37/64	.578125	14.684
19/32	.59375	15.081
39/64	.609375	15.478
5/8	.625	15.875
41/64	.640625	16.272
21/32	.65625	16.669
43/64	.671875	17.066
11/16	.6875	17.463
45/64	.703125	17.859
23/32	.71875	18.256
47/64	.734375	18.653
3/4	.750	19.05
49/64	.765625	19.447
25/32	.78125	19.844
51/64	.796875	20.241
13/16	.8125	20.638
53/64	.828125	21.034
27/32	.84375	21.431
55/64	.859375	21.828
7/8	.875	22.225
57/64	.890625	22.622
29/32	.90625	23.019
59/64	.921875	23.416
15/16	.9375	23.813
61/64	.953125	24.209
31/32	.96875	24.606
63/64	.984375	25.003
1	1.00	25.4

TORQUE CONVERSION

NEWTON METRES (N·m)	POUND-FEET (LB-FT)
1	0.7376
2	1.5
3	2.2
4	3.0
5	3.7
6	4.4
7	5.2
8	5.9
9	6.6
10	7.4
15	11.1
20	14.8
25	18.4
30	22.1
35	25.8
40	29.5
50	36.9
60	44.3
70	51.6
80	59.0
90	66.4
100	73.8
110	81.1
120	88.5
130	95.9
140	103.3
150	110.6
160	118.0
170	125.4
180	132.8
190	140.1
200	147.5
225	166.0
250	184.4

POUND-FEET (LB-FT)	NEWTON METRES (N·m)
1	1.356
2	2.7
3	4.0
4	5.4
5	6.8
6	8.1
7	9.5
8	10.8
9	12.2
10	13.6
15	20.3
20	27.1
25	33.9
30	40.7
35	47.5
40	54.2
45	61.0
50	67.8
55	74.6
60	81.4
65	88.1
70	94.9
75	101.7
80	108.5
90	122.0
100	135.6
110	149.1
120	162.7
130	176.3
140	189.8
150	203.4
160	216.9
170	230.5
180	244.0

GROUP

IDENTIFICATION 10

SECTION 10-01 Vehicle Identification

SUBJECT	PAGE
DESCRIPTION	
Build Date Identification	10-01-2
Color and Trim Combinations—1985, 86 and 87	10-01-7
Color and Trim Combinations—1988	10-01-8
Component VIN Labels—1988 Models	10-01-3
Engine Lable Location—1988 Models	10-01-5

SUBJECT	PAGE
DESCRIPTION (Cont'd.)	
Label Locations—1988 Models	10-01-3
Official Vehicle Identification Number	10-01-1
Replacement Label—1988 Models	10-01-3
Transmission Lable Locations—1988	10-01-6
Vehicle Certification Label	10-01-1

DESCRIPTION

Official Vehicle Identification Number

The official Vehicle Identification Number (VIN) for title and registration purposes is stamped on a metal tab that is fastened to the instrument panel close to the windshield on the driver's side.

Vehicle Certification Label

The Vehicle Certification Label is affixed on the left front door lock panel. The upper half of the label contains the name of the manufacturer, month and year of manufacture, Gross Vehicle Weight Rating (GVWR), Gross Axle Weight Rating (GAWR), and the certification statement.

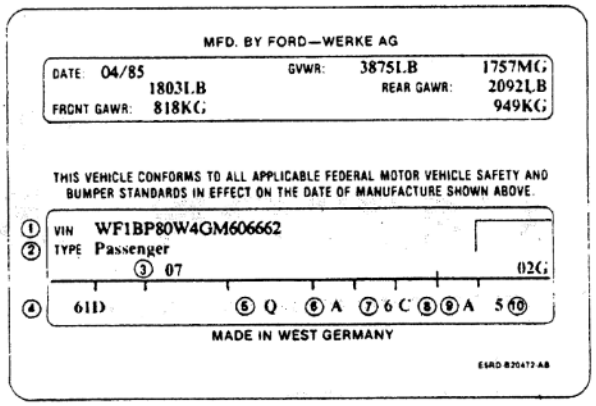
The Vehicle Certification also contains a 17 character Vehicle Identification Number. This number is used for warranty identification of the vehicle and indicates: manufacturer, type of restraint system, line, series, body type, engine, model year and consecutive unit number.

The last six digits of the Vehicle Identification Label indicate the Consecutive Unit Number of each unit built at each assembly plant. The consecutive Unit Numbers begin as follows: 600 001 through 999 999—Lincoln/Mercury Division Vehicles.

The remaining information of the Vehicle Certification Label for the XR4Ti consists of the following vehicle identification codes: color and body type, and interior trim. Additional codes indicate air conditioning, radio type, sun roof type (if any), as well as axle, transmission, spring, district and special order codes.

The following charts provide various codes and their respective identification.

DESCRIPTION (Continued)

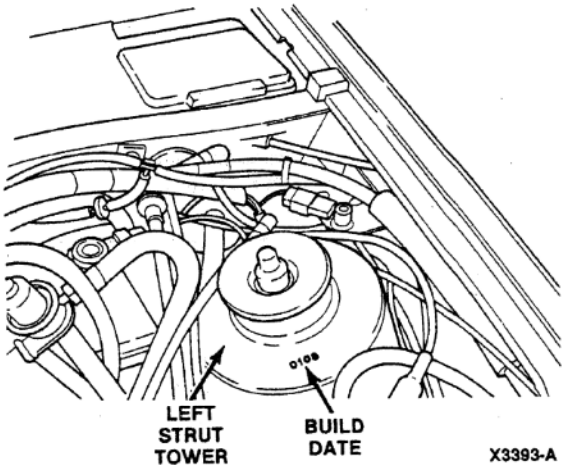


1. Vehicle Identification Number
2. Vehicle Type
3. Paint
4. Body Type Code
5. Interior Trim
6. Air Conditioning
7. Radio
8. Sunroof
9. Axle Ratio
10. Transmission

CY2751

Build Date Identification

Ink stamp on left strut tower.



X3393-A

MERKUR XR4Ti

SAMPLE VIN (VEHICLE IDENTIFICATION NUMBER) DECODING PROCESS

W F 1	B	P 8 0	W	0-9 or X	G	M	6 0 6 7 3 3
Positions 1-3	Position 4	Positions 6-7	Position 8	Position 9	Position 10	Position 11	Positions 12-17
World Manufacturer Identifier	Restraint System Type Passenger Car Only Active Belt-B Passive Belt-P	Line Series, Body Type Constant-P (Passenger)	Engine Type	Check Digit	Model Year 1986	Assembly Plant Karmann	Production Sequence Number

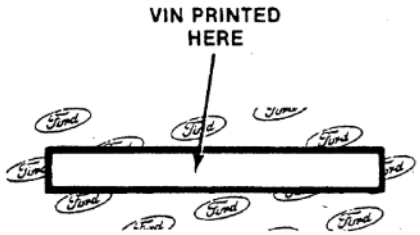
CY2752

DESCRIPTION (Continued)

Component VIN Labels—1988 Models

Federal regulations on vehicle theft protection require that vehicle identification number (VIN) labels be applied at the assembly plant on various body panels and components. The parts from one vehicle cannot be used on another vehicle. These labels contain the complete 17-digit VIN number.

Original Label



Y3926-A

Replacement Label—1988 Models

If a panel or component must be replaced, the new part must be obtained from the Ford Motor Company parts system. These replacement parts must have a replacement part label on them. If the part does not have this label, it cannot be used.



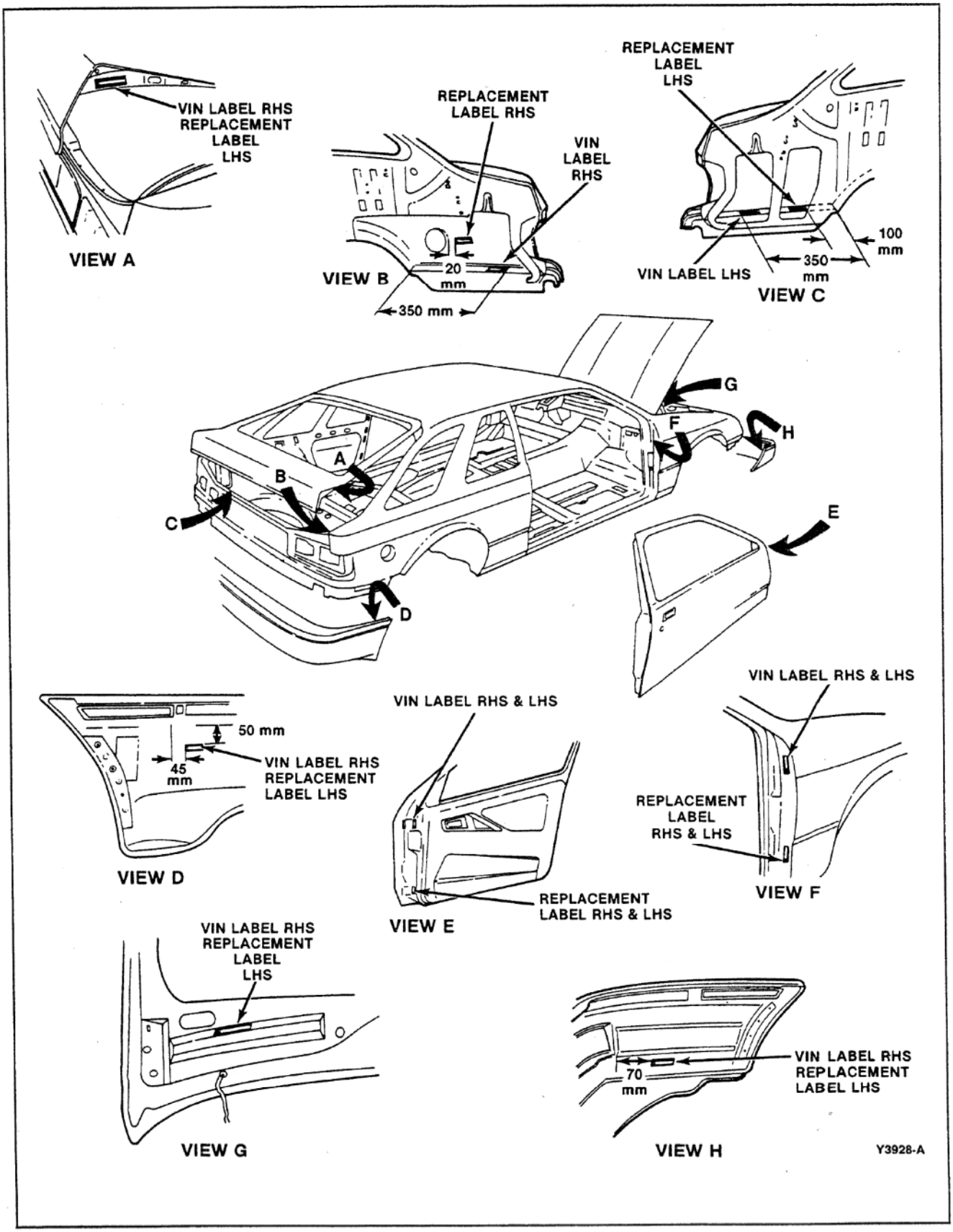
Y3927-A

Label Locations—1988 Models

Refer to the following illustration for the locations of the original VIN number and replacement part labels.

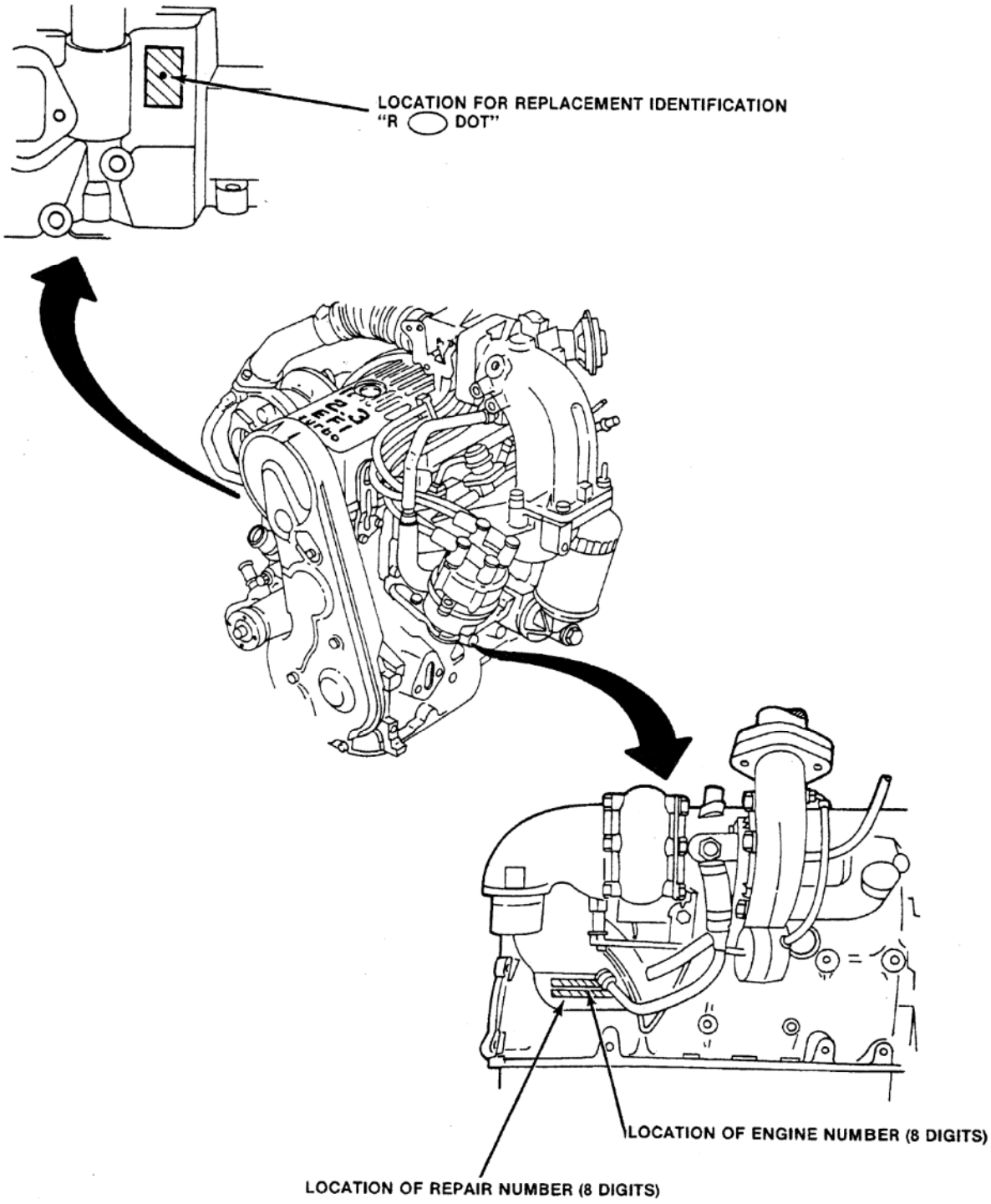
On engines and transmissions, the last eight digits of the VIN number are stamped onto metal bosses. Replacement engines and transmissions have the 8-digit repair number and the R Ford DOT labels applied in the locations shown.

DESCRIPTION (Continued)



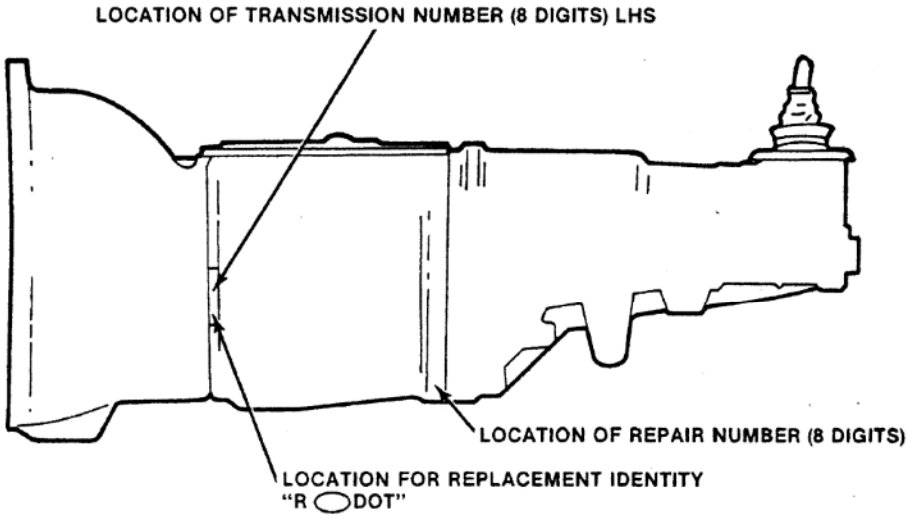
DESCRIPTION (Continued)

Engine Lable Location—1988 Models

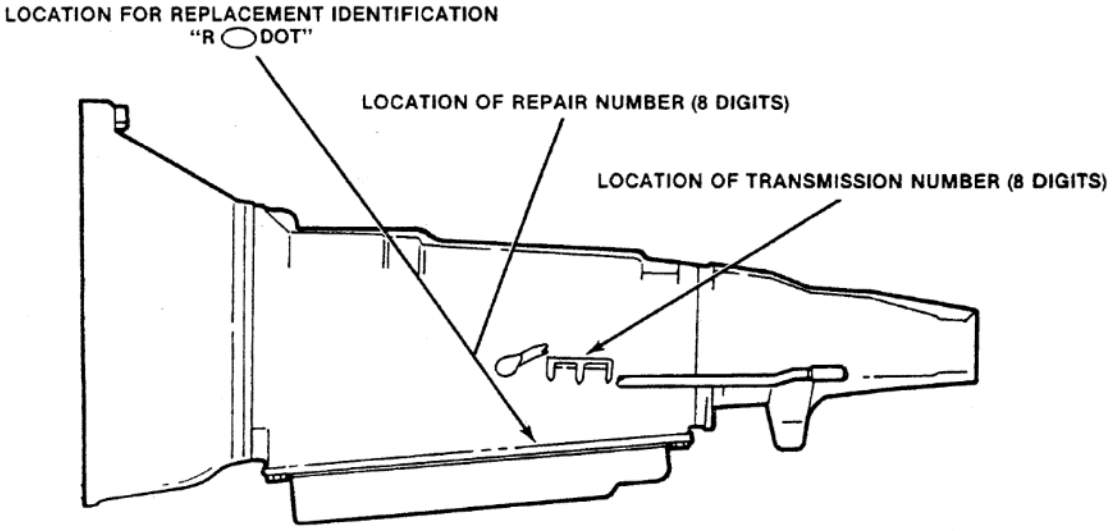


DESCRIPTION (Continued)

Transmission Lable Locations—1988



MANUAL TRANSMISSION



AUTOMATIC TRANSMISSION

Y3930-A

DESCRIPTION (Continued)

Color and Trim Combinations—1985, 86 and 87

Steering Wheel, Column Shroud Only									
					Raven	Raven	Raven		
Seating Material					Oxford		Leather RPO	Bumper Colors	Bodyside Cladding	Bumper/ Cladding Insert
Trim Color: Seat/Door Trim/Carpet/Crashpad/ Console					Steel Grey	Saxe Blue	Steel Grey			
Body Colors	Model Year Availability			Paint Code	Interior Trim Code CQ	CD	XQ			
METALLIC										
• Strato Silver (1056)	85	86	87	0V	X	NA	X			
• Nimbus Grey (1801)	85	86	—	07	X	NA	X			
• Regency Red (1803)	85	86	87*	04	X	NA	X			
• Paris Blue (1900)	85	—	—	03	NA	X	X			
• Azure Blue (1694)	—	86	87	0T	NA	X	X	Dray Grey (1823)	Dark Grey (1823)	Maple Red (1758)
• Mineral Blue (1901)	85	86	—	05	NA	X	X			
• Blue Grey Metallic (2076)	—	—	87	0Q						
• Crystal Blue (2078)	—	—	87	0U						
• Regal Red (2080)	—	—	87**	0O						
SOLID										
• Rosso Red (1933)	85	86	87	0R	X	NA	X			
• Black (632)	85	86	87	0A	X	NA	X	***	***	
• Diamond White (691)	85	86	87	0B	X	NA	X	***	***	

* Early 87 models.

** Available on late 87 models (replaces paint code 04).

*** Bumper and bodyside cladding colors are the same as body color for Black (632) and Diamond White (691) models built after 2-17-87.

CY2753-C

DESCRIPTION (Continued)

Color and Trim Combinations—1988

Steering Wheel, Column Shroud Instrument Surround, Console Inserts		Black	Black	Bumpers and Cladding Colors	Bumper/ Cladding Insert
Seating Material — Mallory/Angora (Standard) — Leather (Optional)					
Trim Colors		Raven/ Shadow Grey	Mace		
BODY COLORS: METALLIC	XSC NOS.				
• Strato Silver	1056	X	NA	Dark Grey (1823)	
• Silica Gold	2089	NA	X	Brown (2044)	
• Magenta (Mica)	2159	X	NA	Dark Grey (1823)	
• Crystal Blue	2078	X	NA	Dark Grey (1823)	Bright Silver (1752)
• Chestnut	2022	NA	X	Brown (2044)	
• Biscay	2153	X	NA	Dark Grey (1823)	
SOLID					
• Black	632	X	NA	Black (632)	
• Diamond White	691	X	NA	White (691)	
• Rosso Red	1933	X	NA	Dark Grey (1823)	

CY3931-A

WHEELS AND TIRES

GROUP 11 (1000)

TITLE SECTION PAGE NO. TITLE SECTION PAGE NO.

WHEEL AND TIRE DIAGNOSIS 11-01

TIRE INSPECTION
- Tire Wear 1
- Tire Pressure 2
- Troubleshooting Chart—Tire Wear 4

TIRE ROUGHNESS AND VIBRATION TROUBLESHOOTING
- General Information 5
- Road Test 5
- Troubleshooting Chart—Wheel/Tire Vibration 6
- Troubleshooting Chart—Wheel/Tire Runout 8

TIRE AND WHEEL BALANCE
- General Information 10
- Static Tire Balance 11
- Dynamic Tire Balance 11
- Off-Vehicle Balancing 11
- On-Vehicle Balancing 11

SPECIFICATIONS 12

REAR WHEEL BEARINGS AND HUBS 11-15

DESCRIPTION 1

REMOVAL AND INSTALLATION
- Bearing Hub 2

DISASSEMBLY AND ASSEMBLY
- Bearing Hub Disassembly 4
- Component Inspection Chart 6
- Assembly 7

FRONT WHEEL BEARINGS AND SPINDLE CARRIERS 11-16

DESCRIPTION 1

REMOVAL AND INSTALLATION
- Spindle Carrier 2

DISASSEMBLY AND ASSEMBLY
- Spindle Carrier Disassembly 5
- Component Inspection Chart 7
- Spindle Carrier Assembly 8

WHEELS AND TIRES 11-17

DESCRIPTION
- General Information 1
- Tire Size 2
- Temporal Spare 3

MAINTENANCE
- Cleaning 3
- Tire Inflation Pressures 4
- Tire Rotation 5
- Tire Service Puncture Repair 5

REMOVAL AND INSTALLATION
- Wheel and Tire Assembly 6
- Wheel Stud 6

GROUP 11

SPECIFICATIONS 1

BEARING INSPECTION CHART 2

GROUP

WHEELS AND TIRES 11

(1000 & 2000)

SECTION TITLE	PAGE
FRONT WHEEL BEARINGS AND SPINDLE CARRIERS	11-16-1
REAR WHEEL BEARINGS AND HUBS	11-15-1
SPECIFICATIONS	11-00-1
WHEEL AND TIRE DIAGNOSIS	11-01-1
WHEELS AND TIRES	11-17-1

SECTION 11-01 Wheel and Tire Diagnosis

SUBJECT	PAGE
TIRE AND WHEEL BALANCE	
Dynamic Tire Balance	11-01-10
General Information	11-01-10
Off-Vehicle Balancing	11-01-11
On-Vehicle Balancing	11-01-11
Static Tire Balance	11-01-10
TIRE INSPECTION	
Tire Pressure	11-01-2
TIRE INSPECTION (Cont'd.)	
Tire Wear	11-01-1
TIRE ROUGHNESS AND VIBRATION	
Road Test	11-01-5
Tire Lead Troubleshooting	11-01-9
Troubleshooting	11-01-5
Wheel/Tire Runout Troubleshooting	11-01-8

TIRE INSPECTION

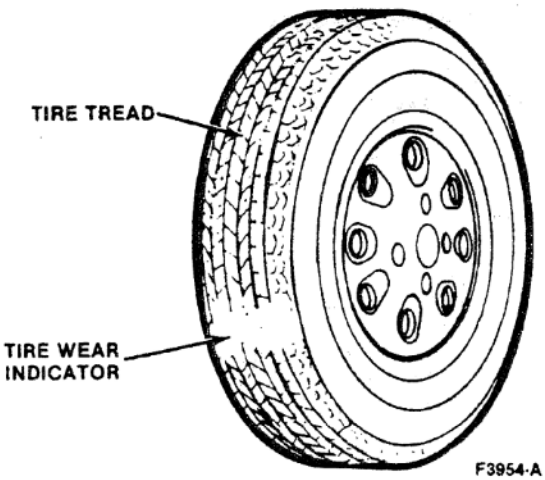
Tire Wear

To maximize tire performance, inspect them for signs of improper inflation and uneven wear, which may indicate a need for balancing, rotation, or front suspension alignment. If the tires have uneven or abnormal wear patterns, refer to the Tire Wear Troubleshooting Chart in this Section.

TIRE INSPECTION (Continued)

Check tires frequently for cuts, stone bruises, abrasions, blisters, and for objects that may have become imbedded in the tread. More frequent inspections are recommended when rapid or extreme temperature changes occur, or where road surfaces are rough or occasionally littered with debris.

As a further visible check of tire condition, tread wear indicators are molded into the bottom of the tread grooves. These indicators will appear as 12.7mm (1/2 in.) wide bands when the tire tread depth becomes 1.6mm (1/16 in.). When the indicators appear in two or more adjacent grooves, at three locations around the tire, or when cord or fabric is exposed, tire replacement due to tread wear is recommended.



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Tire Pressure

Always check tire inflation pressures using an accurate gauge and inflate the tires to recommended levels only.

The tire inflation pressure is carefully calculated to give the vehicle satisfactory ride and steering characteristics while not compromising long tire tread life. The recommended vehicle load capacities and tire inflation pressures for full or reduced load operation are listed in the Tire Inflation Pressure Chart. This information is also provided in the Owner's Guide and on a label attached to the inside edge of the passenger door.

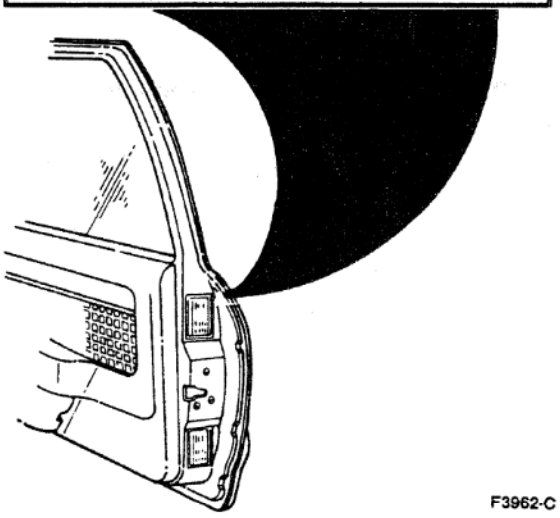
XR4Ti	RECOMMENDED TIRE SIZE AND INFLATION PRESSURE (COLD)	1

TIRE SIZE	VEHICLE LOAD	PRESSURE FRONT	PRESSURE REAR
195/60 HR14* 85/86 195/60 HR15 87/88	LIGHT	26 PSI 180 kPa	26 PSI 180 kPa
195/60 HR14* 85/86 195/60 HR15 87/88	MAXIMUM	32 PSI 221 kPa	32 PSI 221 kPa
T115/70D15 TEMPORAL SPARE	T	60 PSI 415 kPa	60 PSI 415 kPa

*MUST BE REPLACED WITH AN EQUIVALENT TYPE SPEED RATED TIRE.

ALL MODELS	LIGHT LOAD 750 lb./340 kg	TOTAL OCCUPANTS 4	2 FRONT 2 REAR	LUGGAGE 150 lb./68kg.
ALL MODELS	MAXIMUM LOAD 900 lb./408 kg	TOTAL OCCUPANTS 5	2 FRONT 3 REAR	LUGGAGE 150 lb./68 kg.

FOR SUSTAINED HIGH SPEED, TRAILER TOWING, RECREATIONAL ACCESSORIES AND TEMPORAL SPARE USAGE—SEE OWNER'S GUIDE. ▽ ESRD-1532-AC



F3962-C

kPa	psi	kPa	psi
140	20	215	31
145	21	220	32
155	22	230	33
160	23	235	34
165	24	240	35
170	25	250	36
180	26	275	40
185	27	310	45
190	28	345	50
200	29	380	55
205	30	415	60

CONVERSION: 6.9 kPa = 1 psi CF3963-A

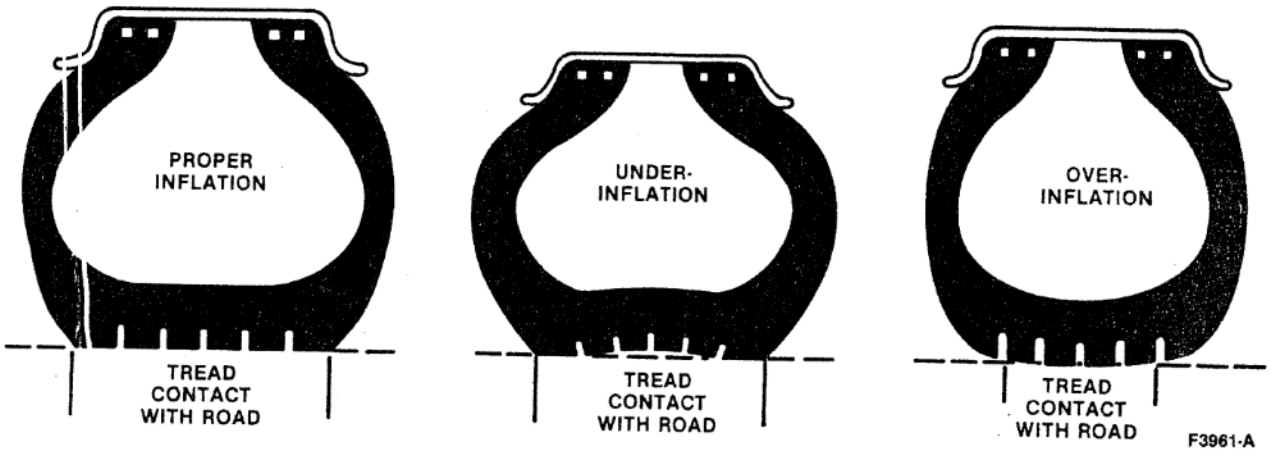
Check and adjust tire inflation pressures only when the tires are cold (vehicle has been parked for three hours or more) or driven for less than 3.2 km (2 miles) at speeds below 64 km/h (40 mph).

Do not reduce inflation pressures if the tires are hot, or driven over 3.2 km [2 miles at speeds above 64 km/h (40 mph)] as pressures can increase as much as 41 kPa (6 psi) over cold inflation pressures.

TIRE INSPECTION

TIRE PRESSURE (Continued)

Be sure to reinstall the valve cap. It prevents air leaks and keeps dust out of the valve.



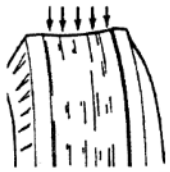
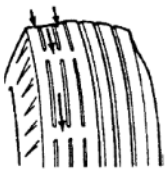
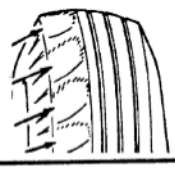
CAUTION: Radial-ply tires have a highly flexible sidewall, which produces a characteristic sidewall bulge making the tire appear underinflated. This is a normal condition for radial-ply tires. Do not attempt to reduce this bulge by overinflating the tire.

Check the condition of the wheels. Replace any wheel that is bent, cracked, severely dented, or has excessive runout. Also, check the condition of the tire inflation valve. Replace the valve if worn, cracked, loose, or leaking air.

It is mandatory to use only the tire sizes recommended on the tire chart attached to the vehicle. Larger or smaller tires can damage the vehicle and affect durability and may require changing the speedometer drive gears. Be sure wheel size and offsets match those recommended for the tire in use.

TIRE INSPECTION

TIRE WEAR TROUBLESHOOTING CHART

CONDITION	POSSIBLE CAUSES	CORRECTIVE ACTIONS
RAPID WEAR AT THE SHOULDERS 	Tires underinflated	Inflate tires to recommend pressure—rotate tires.
	Worn suspension components i.e. Ball joints, upper strut mounts, lower control arm bushings	Replace worn components.
	Excessive cornering speeds	Rotate tires.
RAPID WEAR AT CENTER OF TREND 	Tires overinflated	Inflate tires to recommend pressure—rotate tires.
WEAR AT ONE SHOULDER 	Toe out of adjustment Camber out of specification	Adjust toe to specifications. Check for worn or damaged suspension components.
	Bent lower control arms Bent McPherson struts Bent lower control arm Bent strut tower	Replace lower control arms. Replace strut. Replace lower control arm. Replace strut tower.
FEATHER EDGE 	Toe out of adjustment Bent or worn tie rods Damaged spindle carrier	Adjust toe to specifications. Replace tie rods. Replace spindle carrier.
BALD SPOTS OR TIRE CUPPING 	Unbalanced wheel Excessive radial runout	Balance tire and wheel. Check runout and replace tire if necessary.
	Shock absorber in strut worn	Replace strut.
TIRE SCALLOPED 	Toe out of adjustment Camber out of specification	Adjust toe to specifications. Check for worn or damaged suspension components.
	Worn suspension components i.e. Ball joints, weak struts	Replace worn suspension components.

CF3965-A

TIRE ROUGHNESS AND VIBRATION TROUBLESHOOTING

GENERAL INFORMATION

Vibration, roughness, tramp, shimmy, and thump may be caused by excessive tire or wheel runout, worn or cupped tires, or wheel and tire unbalance. These problem conditions may also be caused by rough or undulating road surfaces. Driving the vehicle on different types of road surfaces will indicate if the road surfaces are actually causing the problem.

Do not immediately suspect the tires when attempting to diagnose a vibration problem. Other sources of vibration include:

- Loose or worn front wheel bearings
- Loose or worn suspension or steering components
- Incorrect universal joint angles
- Worn universal joints
- Excessive propeller shaft or yoke runout
- Rotor or brake drum runout
- Loose engine or transmission supports
- Engine-driven accessories.

This section of the manual will cover only those vibrations related to the tires and wheels.

For diagnostic procedures and repairs for non-tire-related vibrations, refer to Section 18-01, Noise and Vibration Diagnosis.

ROAD TEST

A tire vibration diagnostic procedure always begins with a road test. The road test and customer interview (if available) will provide much of the information needed to find the source of a vibration.

During the road test, drive the vehicle on a road that is smooth and free of undulations. If vibration is apparent, note and record the following:

- The speed range(s) in which the vibration occurs.
- What type of vibration occurs in each speed range—mechanical or audible.
- How the vibration is affected by changes in vehicle speed, engine speed, and engine torque.
- Type of vibration sensitivity—torque sensitive, vehicle speed sensitive, or engine speed sensitive.

Use the following explanations to help isolate the source of the vibration.

Torque Sensitive

This means that the condition can be improved or worsened by accelerating, decelerating, coasting, maintaining a steady vehicle speed and application of engine torque.

Vehicle Speed Sensitive

This means that the vibration always occurs at the same vehicle speed and is not affected by engine torque, engine speed, or transmission gear selected.

Engine Speed Sensitive

This means that the vibration occurs at varying vehicle speeds when a different transmission gear is selected. It can sometimes be isolated by increasing or decreasing engine speed with the transmission in neutral, or by stall testing with the transmission in gear. If the condition is engine-speed sensitive, the problem probably is not related to tires.

If the road test indicates the vibration is related to the tires or wheels, use the Troubleshooting Chart—Wheel/Tire Vibration to help pinpoint the cause of the problem. If the vehicle leads to one side during the road test, refer to the Troubleshooting Chart—Tire Lead.

If a road test indicates that there is tire whine, but no shake or vibration, the noise originates with the contact between the tire and the road surface.

- A THUMPING NOISE usually means that the tire has FLAT or SOFT SPOTS making a noise as they slap the roadway.
- Tire WHINE can be distinguished from axle noise because axle noise diminishes or changes according to load or speed. Tire noise remains the same over a range of speeds.

TIRE ROUGHNESS AND VIBRATION TROUBLESHOOTING

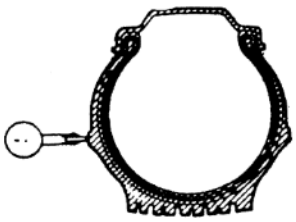
ROAD TEST (Continued)

- To verify that tire noise is not associated with shake or vibration, inflate the tires one at a time to 50 psi and check for a change in the sound. The pitch of a whine will change as the increased pressure changes the tire frequency.

CAUTION: Be sure to deflate tires to their proper pressure after this check is completed.

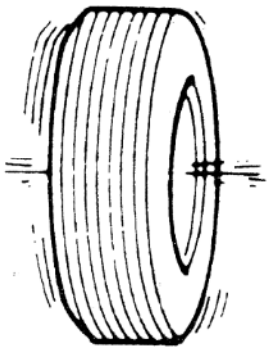
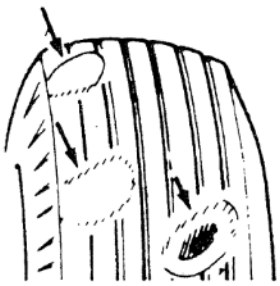
NOTE: A complete road test procedure is provided in Section 18-01, Noise and Vibration Diagnosis.

WHEEL/TIRE VIBRATION TROUBLESHOOTING CHART

CONDITION	POSSIBLE CAUSE
TIRE AND WHEEL LATERAL RUNOUT 	Tire and Wheel Lateral Runout. Not a cause of vibration below 88 km/h (55 mph) unless runout is extreme. Vehicle speed sensitive vibration.
TIRE AND WHEEL RADIAL RUNOUT 	Tire and Wheel Radial Runout. Not a cause of vibration below 32 km/h (20 mph). Speed required to cause vibration increases as runout decreases. Vehicle speed sensitive vibration.
WHEEL HOP 	Wheel Hop. Not a cause of vibration below 32 km/h (20 mph). Produces up-down movement in steering wheel and instrument panel along with mechanical vibration. Most noticeable between 32-64 km/h (20-40 mph). Caused by tires having radial runout of more than 1.14 mm (0.045 inch). Do not attempt to correct by balancing; replace tire. Vehicle speed sensitive vibration.

TIRE ROUGHNESS AND VIBRATION (Continued)

WHEEL/TIRE VIBRATION TROUBLESHOOTING CHART (Continued)

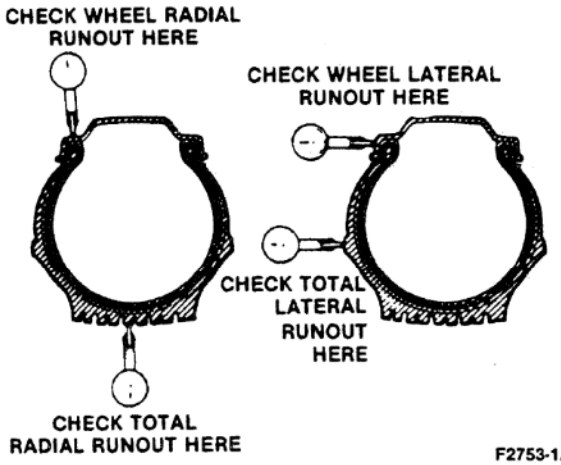
CONDITION	POSSIBLE CAUSE
TIRE BALANCE 	Tire Balance. Static unbalance not a cause of vibration below 48 km/h (30 mph). Dynamic unbalance not a cause under 64 km/h (40 mph). Vehicle speed sensitive vibration.
TIRE WEAR 	Tire Wear. Abnormal wear can cause vibration in 48 to 88 km/h (30 to 55 mph) range and may also generate whine at high speed changing to growl at low speed. Vehicle speed sensitive vibration.
WADDLE	Waddle is side to side movement at the front and/or rear of the vehicle. It is caused by the steel belt not being straight within the tire. It is most noticeable at low speed 5 to 48 km/h (5 to 30 mph). It may also appear as a ride roughness at 80 to 113 km/h (50 to 70 mph). It is possible to road test a vehicle and tell on which end of the vehicle the faulty tire is located. If the waddle tire is on the rear, the rear end of the vehicle will shake from side to side or "waddle." From the driver's seat it feels as though someone is pushing on the side of the vehicle. If the faulty tire is on the front, the waddle is more visual. The front sheet metal appears to be moving back and forth and the driver feels as though he is at the pivot point in the vehicle.

CF3970-A2

TIRE ROUGHNESS AND VIBRATION (Continued)

Wheel/Tire Runout Troubleshooting

Checking Wheel/Tire Runout



F2753-1A

Check wheel and tire runout with the tires inflated to the normal load inflation pressure. To ensure accurate results, make the checks with a dial indicator immediately after the road test. If time is allowed to pass between the road test and runout checks, the tires may develop slight flat spots, which can affect the accuracy of the tire runout checks.

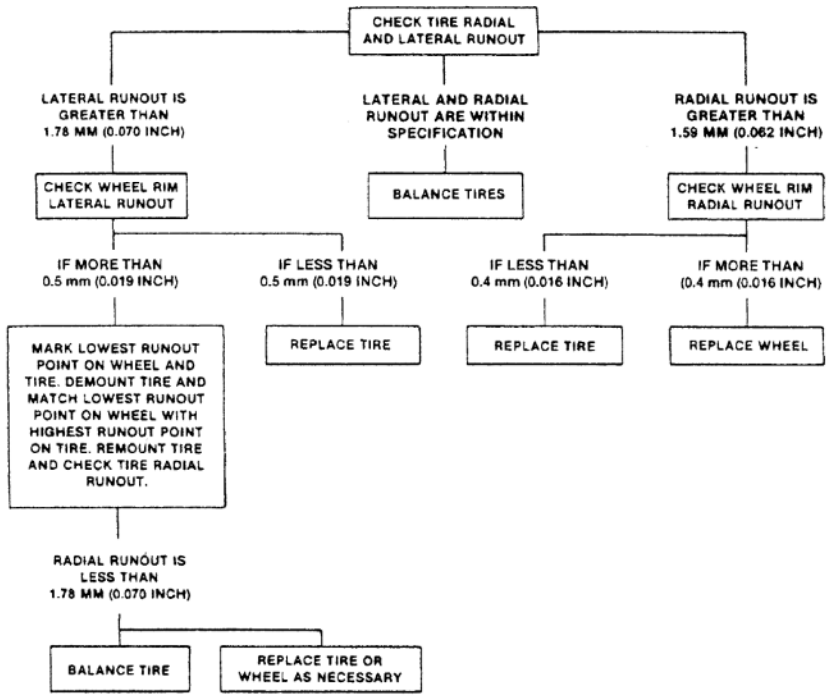
Measure tire radial runout at the center and outside ribs of the tread face. Measure tire lateral runout just above the letters identifying the tire size.

Measure wheel radial runout at the wheel rim along the inside edge of the flange.

Measure wheel lateral runout at the wheel rim bead flange just inside of the curved lip of the flange.

Use Troubleshooting Chart—Wheel/Tire Runout to determine if wheel or tire runout are the source of a vibration problem.

WHEEL/TIRE RUNOUT TROUBLESHOOTING CHART



CF3973-B

TIRE ROUGHNESS AND VIBRATION TROUBLESHOOTING

TIRE LEAD TROUBLESHOOTING

Radial Tire Lead

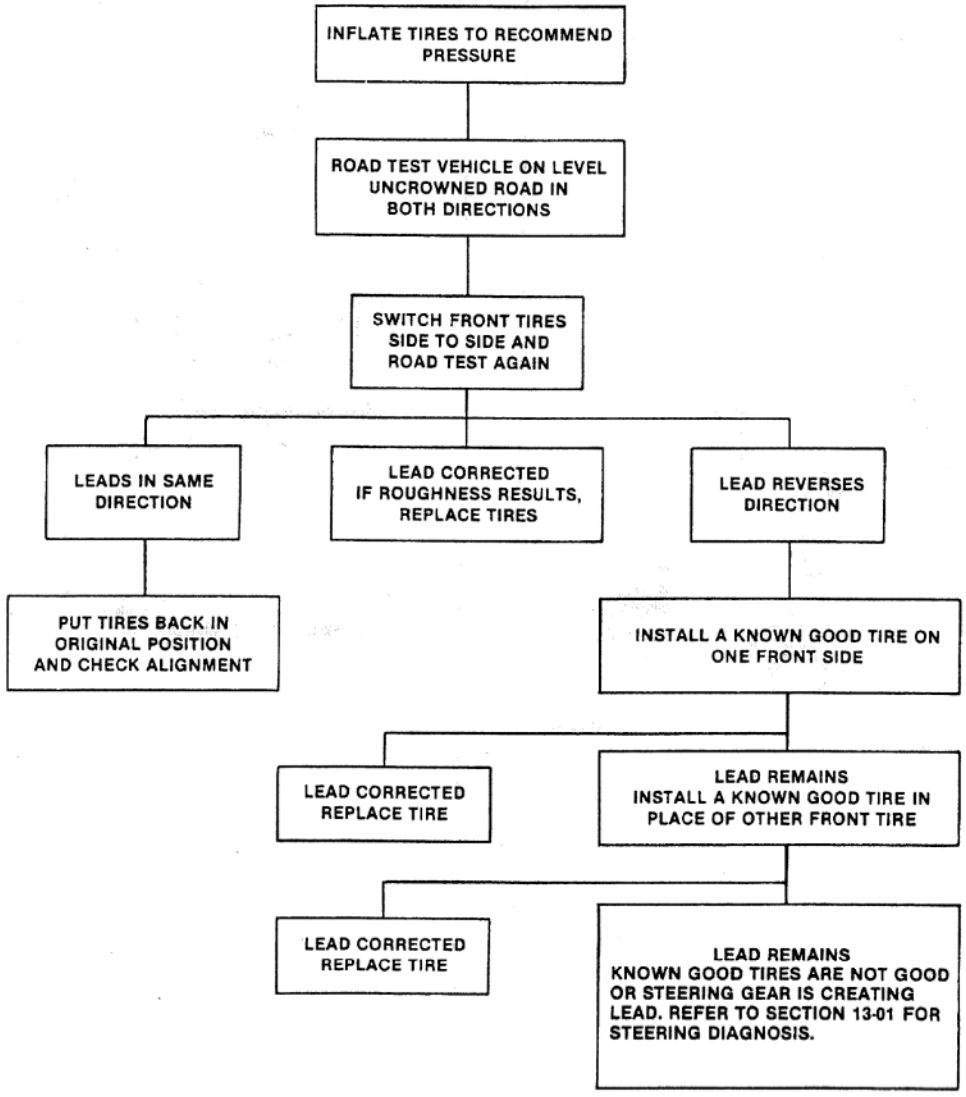
"Lead" is the deviation of the vehicle from a straight path on a level road with no pressure on the steering wheel.

Lead is usually caused by:

- Misalignment
- Uneven brake adjustment
- Uneven or incorrect tire inflation pressures
- Faulty tire construction

The way in which a tire is built can produce lead. An example of this is placement of the belt. Off center belts on radial tires can cause the tire to develop a side force while rolling straight down the road. If one side of the tire is a little larger diameter than the other, the tire will tend to roll to one side. This will develop a side force, which can produce lead.

TIRE LEAD TROUBLESHOOTING CHART



CF3971-A

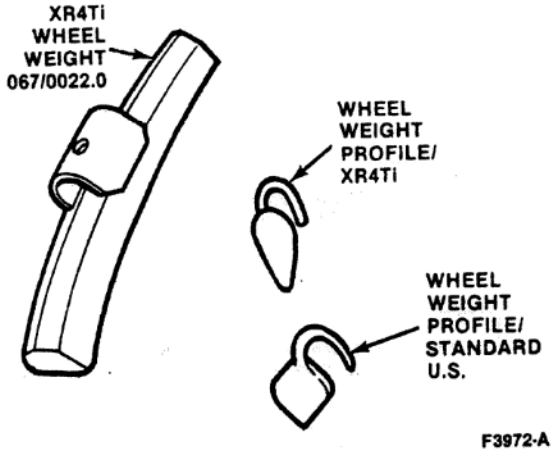
TIRE AND WHEEL BALANCE

GENERAL INFORMATION

Before balancing a tire, clean deposits of dirt and mud from the wheel, both inside and outside rims and remove any existing balance weights.

Remove stones from the tire tread in order to avoid operator injury during spin balancing and to obtain a good balance. Inspect all tires for damage. Check and, if necessary, correct tire pressures, then balance according to the equipment manufacturer's instructions.

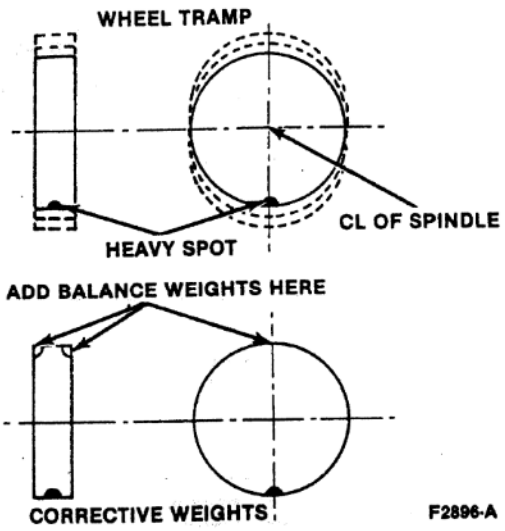
NOTE: The shape of the rim on the aluminum alloy wheel requires a unique wheel weight with a matching contour. Do not attempt to use a steel wheel weight on the aluminum wheel.



STATIC TIRE BALANCE

There are two types of wheel and tire balance: static and dynamic.

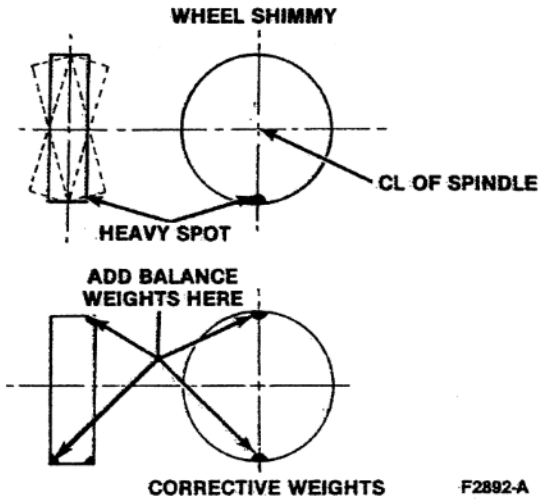
A STATIC balance is the equal distribution of weight around the wheel. Wheels that are statically unbalanced cause a bouncing action called wheel tramp. This condition will eventually cause uneven tire wear.



TIRE AND WHEEL BALANCE

DYNAMIC TIRE BALANCE

A DYNAMIC balance is the equal distribution of weight on each side of the centerline, so that when the wheel spins there is no tendency for a side-to-side movement. Wheels that are dynamically unbalanced may cause wheel shimmy.



There are two types of wheel balancing procedures: off-vehicle and on-vehicle. A brief description of each is provided below.

OFF-VEHICLE BALANCING

When balancing, it is imperative that the wheel is located on the balancer by the center hole **NOT** the stud holes. To ensure positive wheel location, the diameter of the locating collar on the machine spindle must be 63.25 to 63.28 mm (2.490 to 2.491 in.). This diameter allows the collar to fit snugly within the center hole of the wheel.

It is important that the nuts, used for locating the wheel on the machine, have a conical form on the underside of the head to avoid possible wheel damage. Always use the vehicle wheel retaining nuts where possible.

ON-VEHICLE BALANCING

Always refer to the manufacturer's instructions provided with the Rotunda Wheel Balancer 006-01582 and adapter 006-01715, or equivalent, dynamic-type wheel balancer, when balancing wheels on the vehicle.

To balance the front wheels apply the parking brake, chock the rear wheels, lift the front of the vehicle, and install safety stands. Before spinning the wheels, check for looseness in steering and suspension joints, worn wheel bearings and brake grab.

To balance the rear wheels, raise the vehicle high enough to place a block under the tire of the wheel not to be balanced. Lower the vehicle, so the tire sits on the block and the wheel to be balanced is at least two inches off the ground. This procedure will allow only one wheel to spin. Additionally, support the rear suspension arms so that the halfshaft joint angles are at curb weight condition (5° to 9° shaft angle). In this condition, the suspension arm supports will be providing most of the support of the vehicle; the stands being in place as a safety measure. Before spinning the wheels, check for looseness in the suspension joints, worn wheel bearings and brake grab.

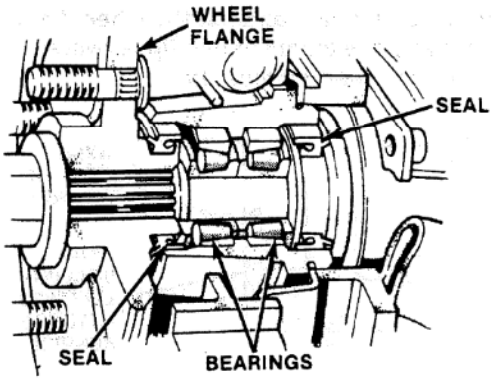
Start the engine, select top gear and accelerate slowly. While balancing the rear wheels, ensure that the wheel spin does not exceed the equivalent road speed of 56 km/h (35 mph).

CAUTION: When balancing the rear wheels on vehicles with a conventional rear axle, limit the wheel spin to 56 km/h (35 mph) as indicated on the speedometer. If care is not taken during the rear wheel balancing procedure, possible tire disintegration, differential and or halfshaft failure can result, which could cause personal injury or extensive component damage.

SECTION 11-15
REAR WHEEL BEARINGS AND HUBS

CONTENTS

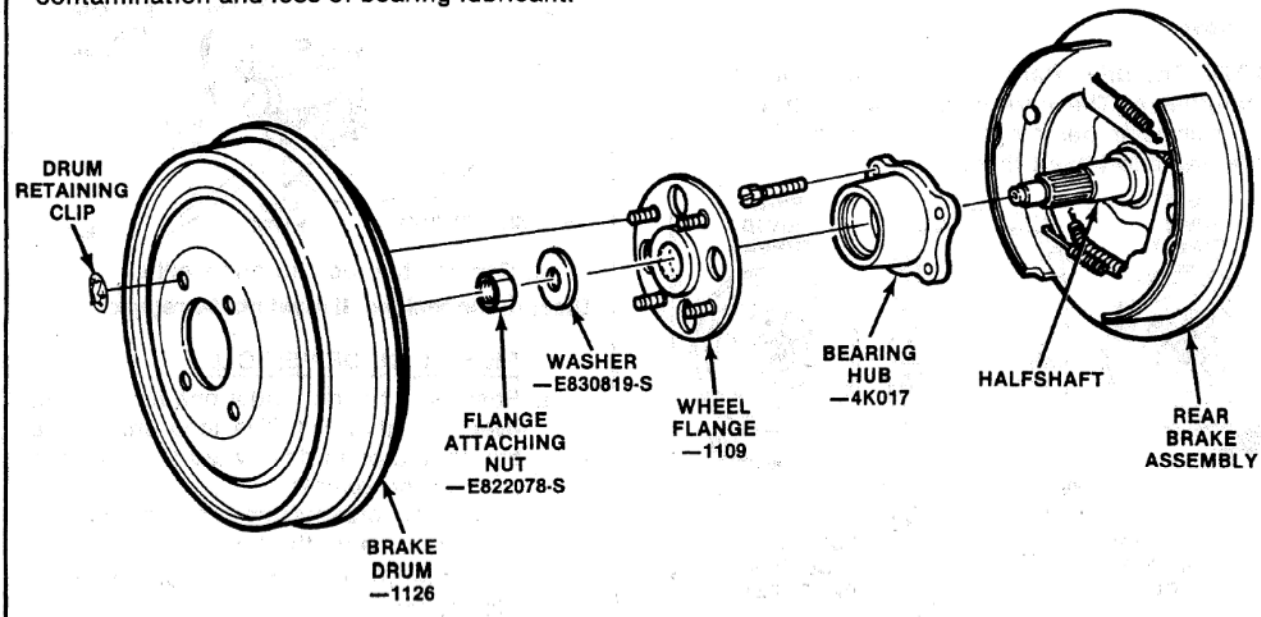
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DISASSEMBLY AND ASSEMBLY	5
Bearing Hub Disassembly	4
Component Inspection Chart	6
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DESCRIPTION

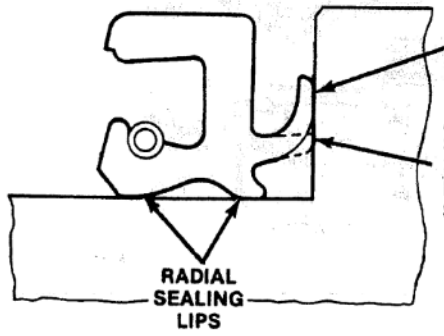
The rear wheel bearings support the outboard ends of the halfshafts in bearing hubs which are bolted to the rear suspension control arms. The bearings are the tapered roller type with the bearing cups pressed into machined seats in the hub. On the inboard and outboard side of the hub, lipped seals are installed to prevent contamination and loss of bearing lubricant.

During manufacture, the components are machined to close tolerances. The result is self-setting wheel bearings that never require adjustment. Also, the rear wheel bearings are lubricated with a grease formulated for long life and lubricating efficiency over a wide temperature range.



DESCRIPTION

To prevent lubricant contamination, triple lip seals are installed on the inboard and outboard sides of the bearing hub. Two of the sealing lips on each seal seat directly against the halfshaft to form radial seals. An axial seal is formed by the third lip as it seats against the wheel flange and halfshaft. The axial sealing lip is oversized, to provide extended service life.



F3952-A

REMOVAL AND INSTALLATION

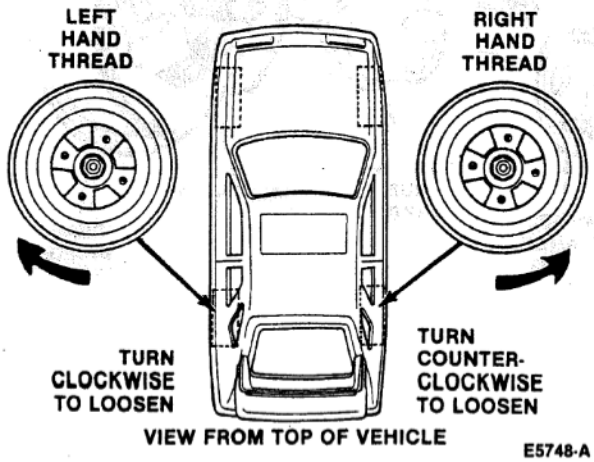
BEARING HUB

SPECIAL SERVICE TOOL REQUIRED:

Puller D81L-1002-A

Removal

NOTE: The drive flange locknuts are not interchangeable. The nuts have opposite threads. The right side has a right-hand thread. The left side has a left-hand thread.



E5748-A

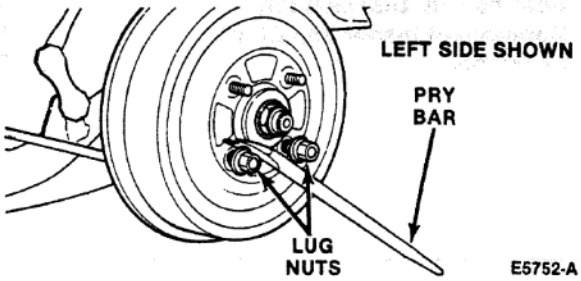
BEARING HUB

Removal (Continued)

1. Remove the wheel.
2. To loosen the flange locknut, install two wheel lug nuts and proceed as follows:

LEFT SIDE OF VEHICLE

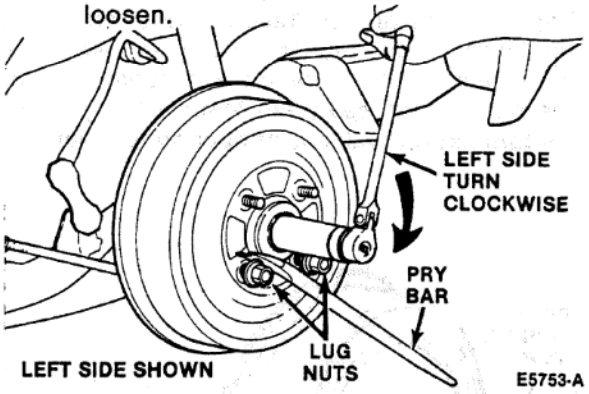
a. Position a pry bar under one lug nut and over the other nut. The long end of the bar should point downward and face the rear of the vehicle.



E5752-A

b. Rotate the brake drum rearward until the pry bar contacts the floor.

c. Turn the flange locknut clockwise to loosen.



E5753-A

d. Remove the locknut and washer.

Discard the locknut; it must not be reused.

RIGHT SIDE OF VEHICLE

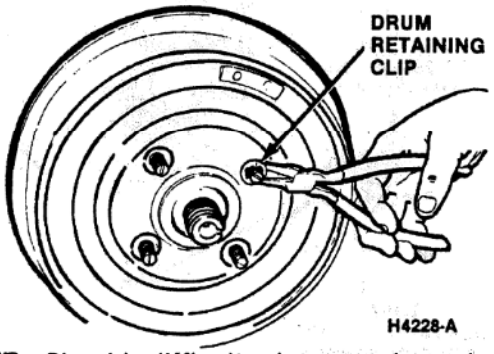
a. Position a pry bar under one lug nut and over the other nut. The long end of the bar should point downward and face the front of the vehicle.
b. Rotate the brake drum forward until the pry bar contacts the floor.
c. Turn the flange locknut counterclockwise to loosen.
d. Remove the locknut and washer.

REMOVAL AND INSTALLATION

BEARING HUB

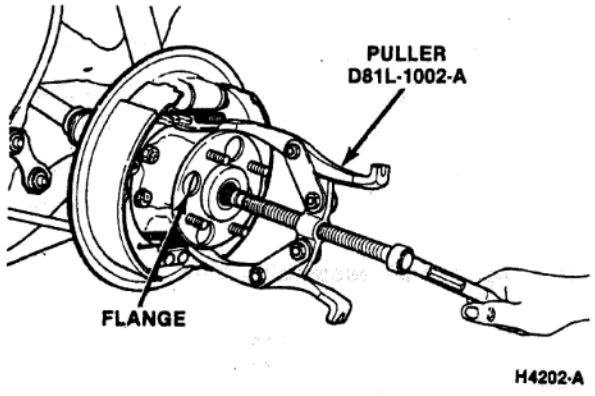
Removal (Continued)

3. Remove the brake drum retaining clip and the brake drum.



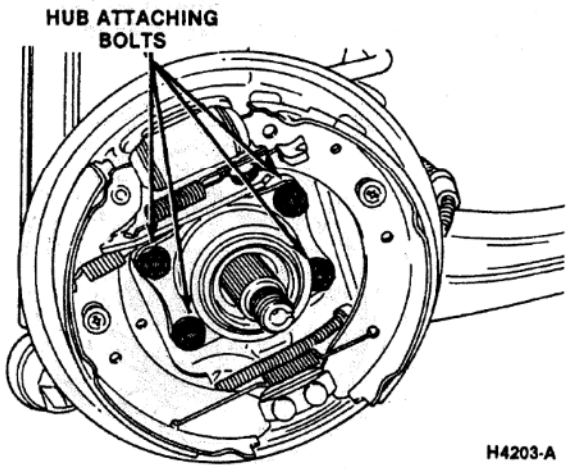
NOTE: Should difficulty be experienced in removal of the brake drums due to the action of the automatic self-adjuster mechanism, the self-adjuster may be released following the procedure in Section 12-02.

4. Remove the drive flange using Puller D81L-1002-A, or equivalent.



5. Support the brake backing plate with a piece of wire.

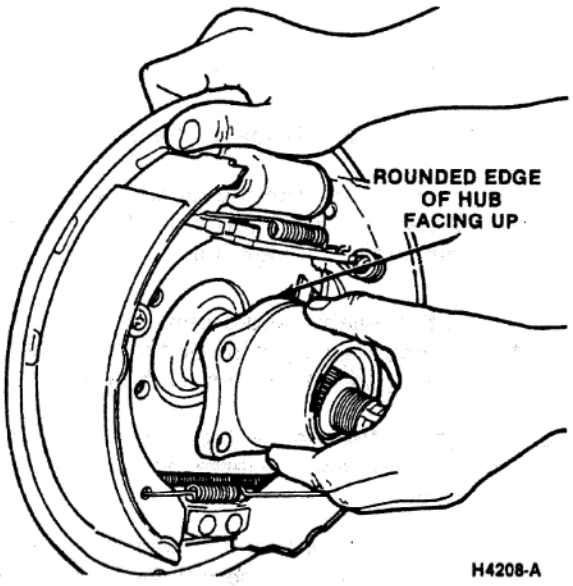
6. Remove the bearing hub attaching bolts and the bearing hub.



BEARING HUB

Installation

1. Install the bearing hub with the rounded edge facing up.

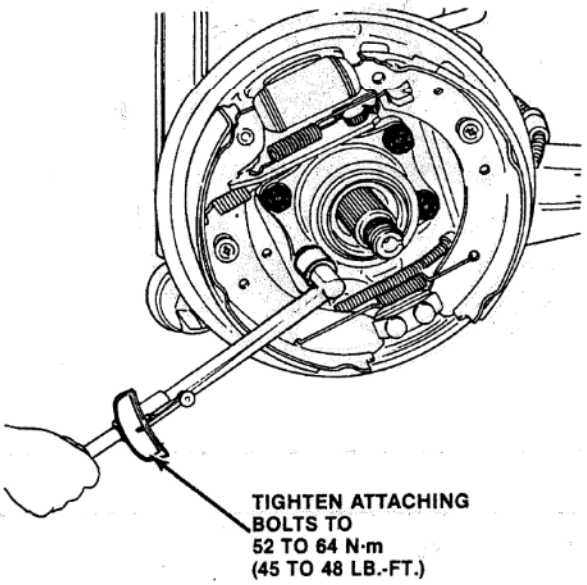


REMOVAL AND INSTALLATION

BEARING HUB

Installation (Continued)

2. Install the bearing hub attaching bolts and tighten to 52 to 64 N·m (45 to 48 lb-ft).



H4230-A

3. Remove the backing plate support wire.

4. Install the wheel flange on the shaft.

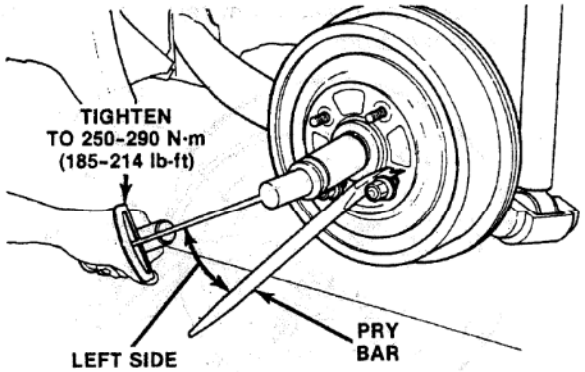
   If necessary, tap the flange with a plastic tipped hammer until the shaft threads extend beyond the flange hub.

5. Install the washer and a new locknut. Turn the nut counterclockwise on the left side of the vehicle and clockwise on the right side.

6. To tighten the flange locknut, install the brake drum and reverse the loosening procedure.

NOTE: If the drum will not fit over the brake shoes, additional clearance can be gained by pushing the self-adjuster toward the release position.

Tighten the flange locknut to 250 to 290 N·m (185 to 214 lb-ft).



E5751-A

7. Install the wheel.

CAUTION: If the self-adjuster was released, push the brake hard twice to set the self-adjuster cam position.

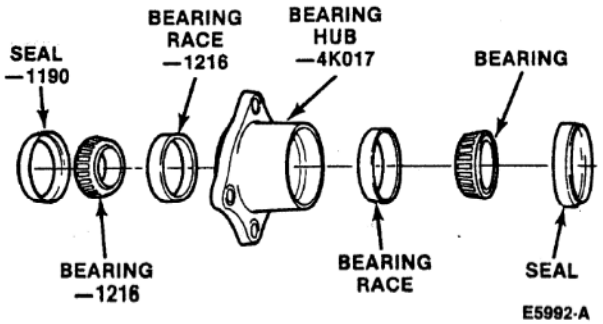
DISASSEMBLY AND ASSEMBLY

BEARING HUB

SPECIAL SERVICE TOOLS REQUIRED:

Bearing Cup Puller	T77F-1102-A
Bearing Cup Replacer	T73T-1202-B
Bearing Cup Replacer	T73T-4222-B
Threaded Drawbar	T77F-1176-A
Seal Replacer	T73T-1190-B
Slide Hammer	T50T-100-A

Bearing Hub Disassembled View



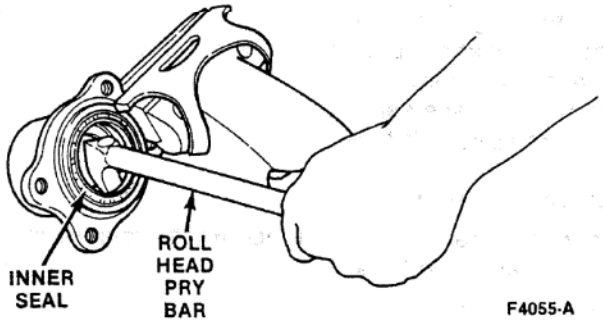
E5992-A

DISASSEMBLY AND ASSEMBLY

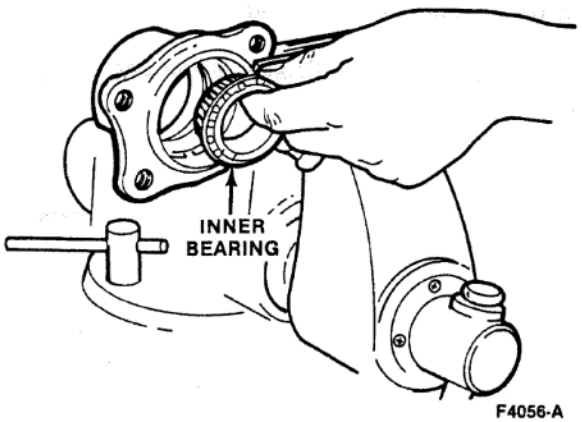
Disassembly

1. Clamp the bearing hub in a vise and remove the inner grease seal using a rollhead pry-bar or screwdriver.

   Discard the seal. It must not be reused.

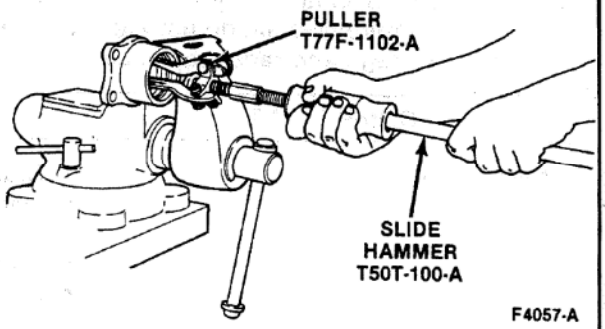


2. Remove the inner bearing from the hub.

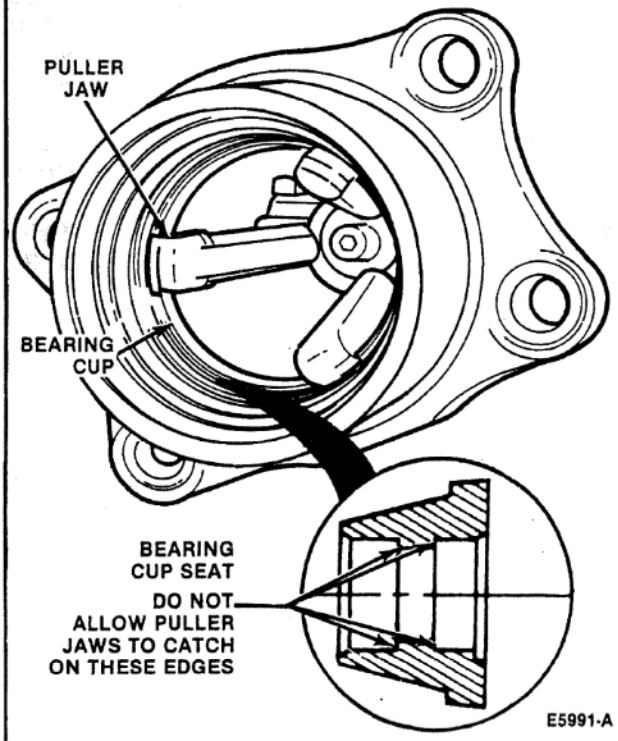


3. Turn the hub over. Remove the outer seal and bearing in the same way.

4. Remove a bearing cup using Bearing Cup Puller T77F-1102-A and Slide Hammer T50T-100-A, or equivalent.



When removing the remaining bearing cup, make sure the puller jaws do not catch against the bearing cup seat in the center of the hub.



DISASSEMBLY AND ASSEMBLY

REAR WHEEL BEARING AND HUBS

COMPONENT INSPECTION CHART

NOTE: Thoroughly clean all parts in solvent and blow dry with compressed air. If the bearings are dried with compressed air, do not allow the roller and cage to spin on the bearing race. Damage to the rollers, cage and race may occur.

COMPONENT	CHECK FOR
BEARING HUB	• Cracks in the bearing hub forging • Evidence that the bearing races have "spun" in the hub • Damaged grease seal seats • Burrs on the bearing race seats • Elongated or damaged bolt holes
DRIVE FLANGE	• Damaged or loose wheel studs **NOTE:** A wheel stud replacement procedure is provided in Section 11-01, wheels and tires • Damaged or worn splines
FLANGE LOCK NUT	• Damaged threads or nylon insert
STUBSHAFT	• Pitted or scored seal surfaces • Evidence that the bearings have "spun" on the shaft • Damaged lock nut threads • Worn or damaged splines • Scored or worn bearing surfaces
CONTROL ARM	• Damage to the hub attaching bolt threads • Cracks in the bearing hub attaching area
BEARINGS	• Refer to the Bearing Inspection Charts at the end of Group 11.

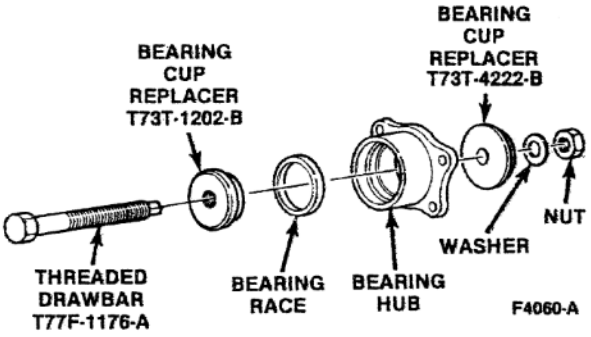
CF4058-A

DISASSEMBLY AND ASSEMBLY

BEARING HUB

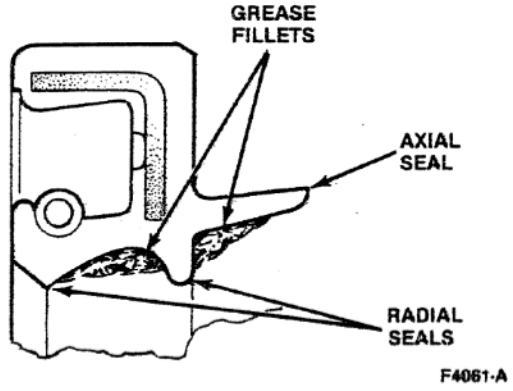
Assembly

1. Install the bearing cups using Bearing Cup Replacer T73T-1202-B, Bearing Cup Replacer T73T-4222-B and Threaded Drawbar T77F-1176-A.

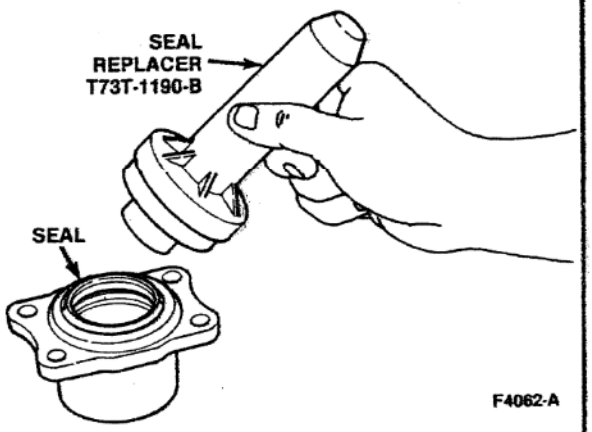


2. Pack the bearing with lubricant CIAZ-19590-B, C, D or E, or equivalent.

3. Lubricate the seal lips with lubricant CIAZ-19590-B, C, D or E, or equivalent. Form the lubricant into a fillet along the seal lip edge.



4. Position a bearing in the hub and install a new bearing seal using Seal Replacer T73T-1190-B, or equivalent.



5. Install the remaining bearing and a new seal in the same manner.

SECTION 11-16 FRONT WHEEL BEARINGS AND SPINDLE CARRIERS

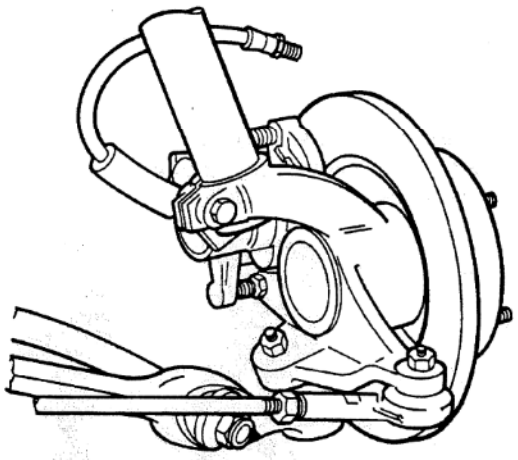
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Spindle Carrier Assembly 8



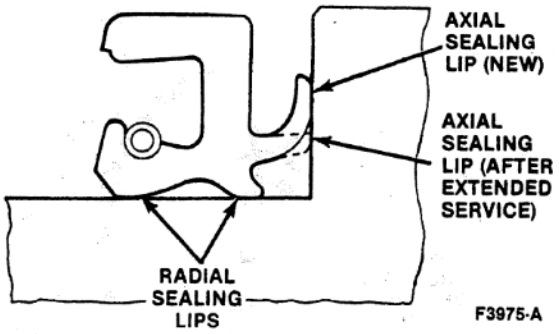
F3974-A

DESCRIPTION

The front wheels on the XR4Ti are attached to spindle shafts which are supported on opposed, tapered roller bearings. The spindle hub casting forms a housing for the bearings and shaft while providing the necessary suspension and steering connection points. During manufacture, these components are machined to close tolerances.

The result is self-setting wheel bearings that never require adjustment. The bearings are lubricated with a grease formulated for long life and lubricating efficiency over a wide temperature range. The lubricant is sealed against contamination and loss by a bearing seal on the outboard side of the carrier and by a stamped steel plug on the inboard side of the carrier.

The bearing seal also has a long service life expectancy due to its three sealing lips. Two of these sealing lips seat directly against the spindle shaft to form radial seals. The third seal seats directly on the flange portion of the shaft and forms an axial seal around the diameter of the flange. The axial sealing lip is oversized, allowing a large amount of wear to occur before seal effectiveness is reduced.



F3975-A

REMOVAL AND INSTALLATION

SPINDLE CARRIER

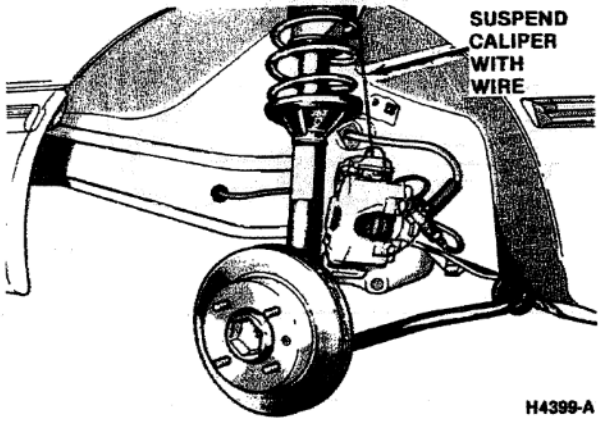
Removal

SPECIAL SERVICE TOOLS REQUIRED:

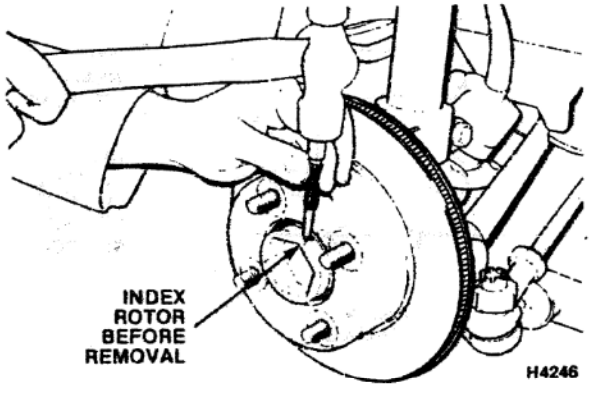
Tie Rod End Separator	T85M-3395-A
Spindle Carrier Lever	T85M-3206-A

Removal

1. Remove the brake caliper and suspend from the body with a piece of wire. If necessary, refer to Section 12-20.



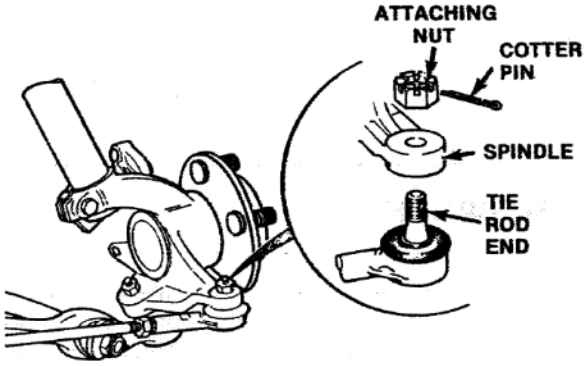
2. Remove the retaining clip and the brake rotor.

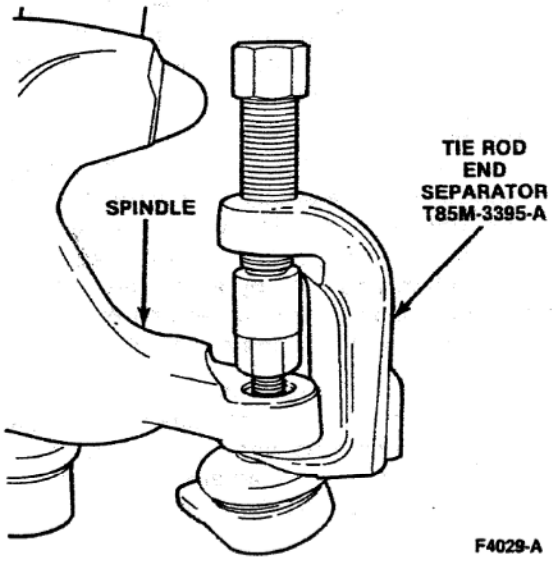


NOTE: The hub and rotor are a matched, balanced assembly. Before removing the rotor, locate the paint or etch mark that indicates proper hub-to-rotor alignment. If the marks are not present, mark the hub and rotor for assembly alignment. Failure to properly align the hub and rotor can result in an imbalance condition.

If the rotor is removed before it is marked, refer to Section 12-20—Disc Brakes for the re-indexing procedure.

3. Remove the cotter pin and the tie rod attaching nut.
4. Separate the tie rod from the spindle using Tie Rod End Separator T85M-3395-A or equivalent.



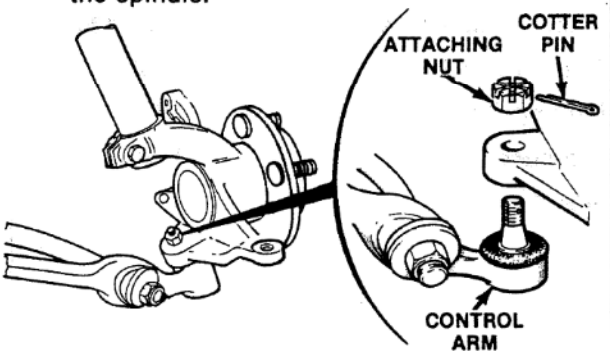


REMOVAL AND INSTALLATION

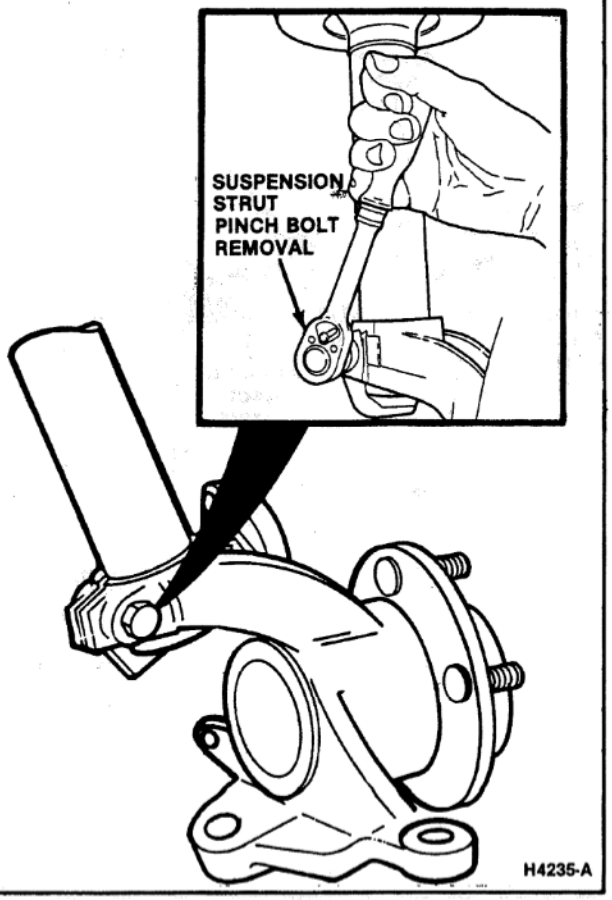
SPINDLE CARRIER

Removal (Continued)

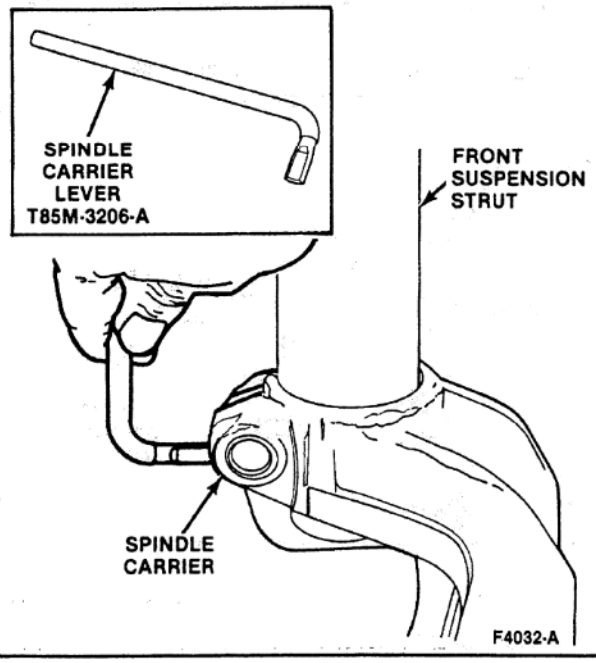
5. Remove the cotter pin and the control arm attaching nut. Separate the control arm from the spindle.



6. Remove the suspension strut pinch bolt.



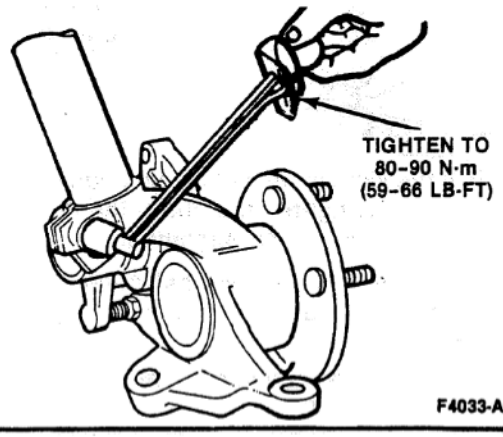
7. Using Spindle Carrier Lever T85M-3206-A, or equivalent, spread the spindle carrier to release from the strut and then remove the spindle carrier.



Installation

1. Spread the spindle carrier using lever T85M-3206-A, or equivalent, and position the spindle carrier on the suspension strut.
2. Remove the lever and install the strut pinch bolt.

   Tighten the bolt to 80 to 90 N·m (59 to 66 lb-ft).



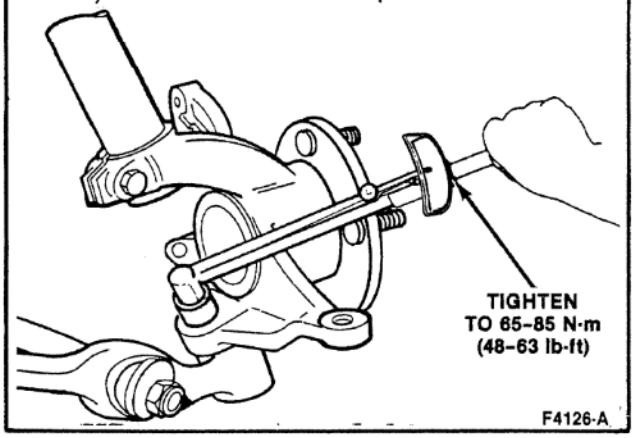
REMOVAL AND INSTALLATION

SPINDLE CARRIER

Installation (Continued)

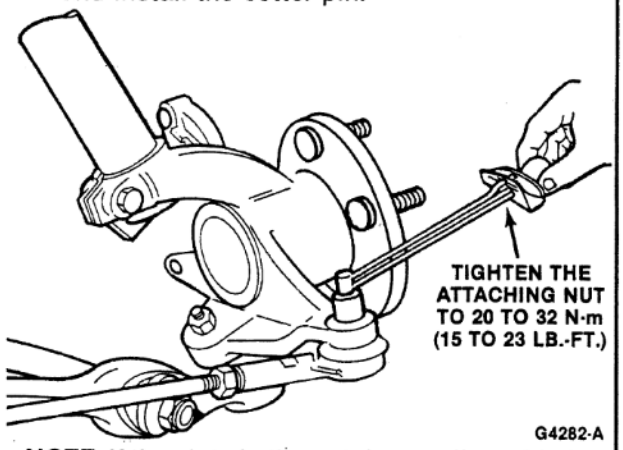
3. Position the lower control arm in the spindle carrier and install the attaching nut.

   Tighten the nut to 65 to 85 N·m (48 to 65 lb-ft) and install the cotter pin.



4. Connect the tie rod to the spindle carrier and install the attaching nut.

   Tighten the nut to 20 to 32 N·m (15 to 23 lb-ft) and install the cotter pin.



NOTE: If the slots in the nut do not align with the cotter pin hole, tighten the nut to the next slot. **Never loosen the nut for alignment.**

5. Install the rotor in its balanced position using the index marks for alignment reference.
6. Install the brake caliper. If necessary, refer to Section 12-20.

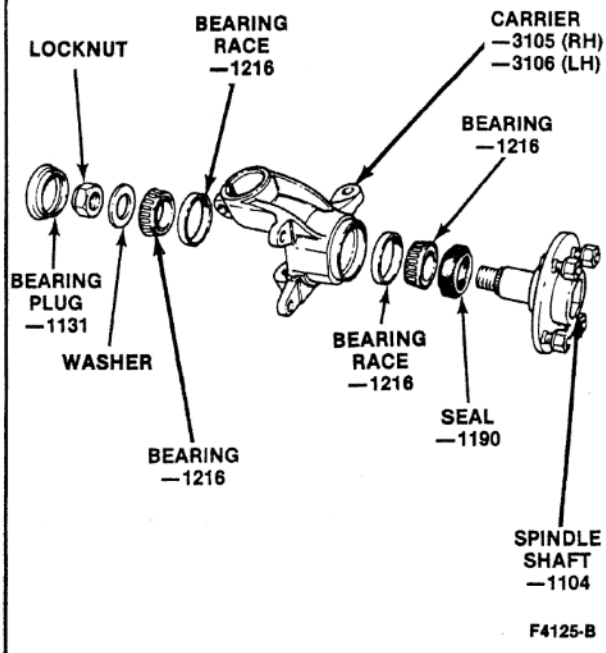
DISASSEMBLY AND ASSEMBLY

SPINDLE CARRIER

SPECIAL SERVICE TOOLS REQUIRED:

Bearing Cup Remover	T77F-1102-A
Slide Hammer	T50T-100-A
Bearing Cup Replacer	T73T-1202-B
Bearing Cup Replacer	T73T-4222-B
Bearing Cup Replacer	T73T-1202-C
Threaded Drawbar	T77F-1176-A
Seal Replacer	T73T-1190-B

Spindle Carrier Disassembled View



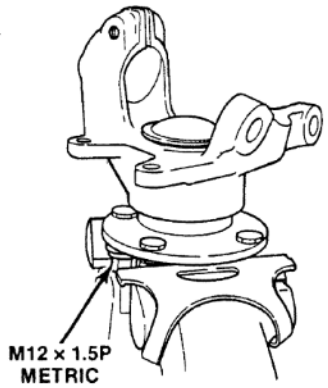
DISASSEMBLY AND ASSEMBLY

SPINDLE CARRIER

Disassembly

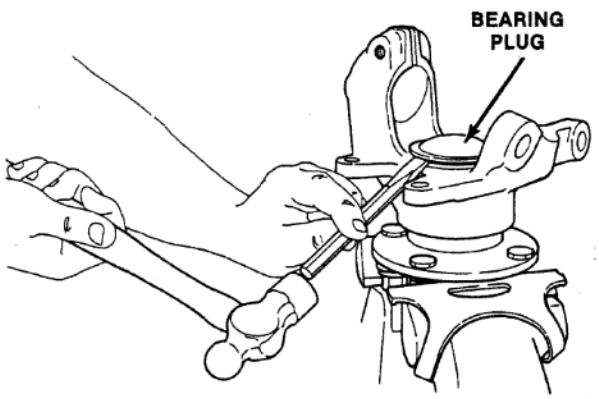
1. Install an M12X1.5P metric nut on each of the wheel studs, run the nut fully down the stud, and clamp the spindle carrier in a vise.

   DO NOT overtighten the vise.



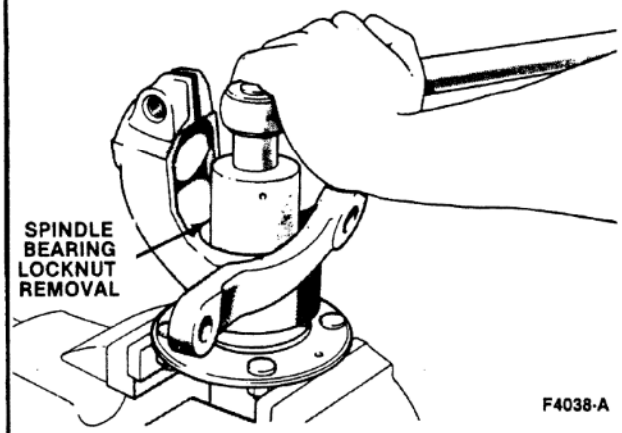
F4036-A

2. Remove the bearing plug.



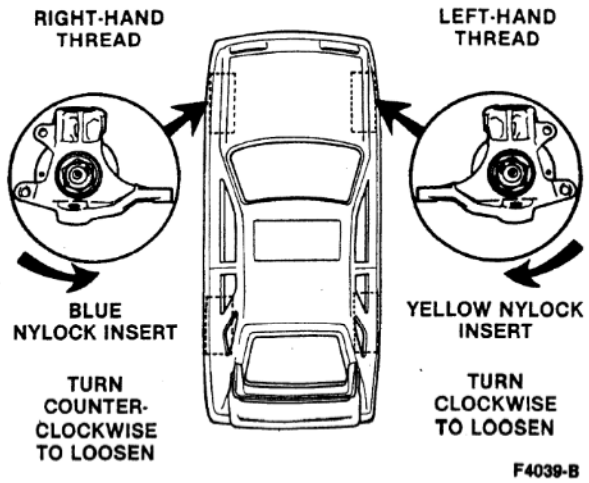
F4037-A

3. Using a 41 mm socket, remove the spindle bearing locknut.



F4038-A

NOTE: The spindle bearing locknut will have right-hand threads if the spindle carrier is from the left side of the vehicle. Turn this nut counter-clockwise to loosen. If the spindle carrier is from the right side of the vehicle, the locknut will have left-hand threads. Turn this nut clockwise to loosen. The side of the vehicle from which the spindle carrier was removed can be identified by inspecting around the edge of the large hexagonal recess in the spindle hub for a stamped in "L" or "R".



F4039-B

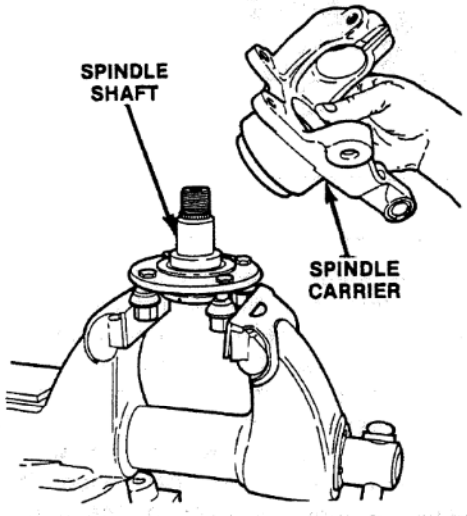
DISASSEMBLY AND ASSEMBLY

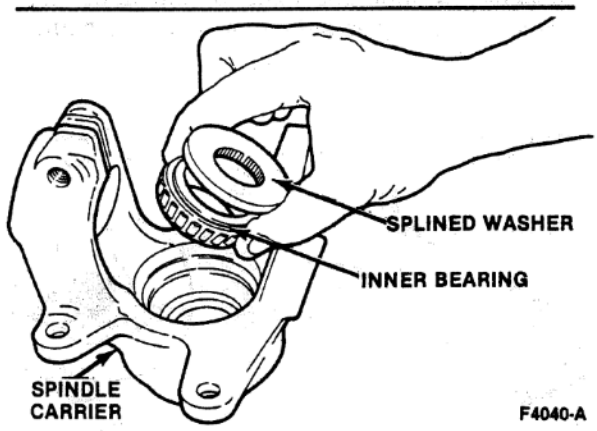
SPINDLE CARRIER

Disassembly (Continued)

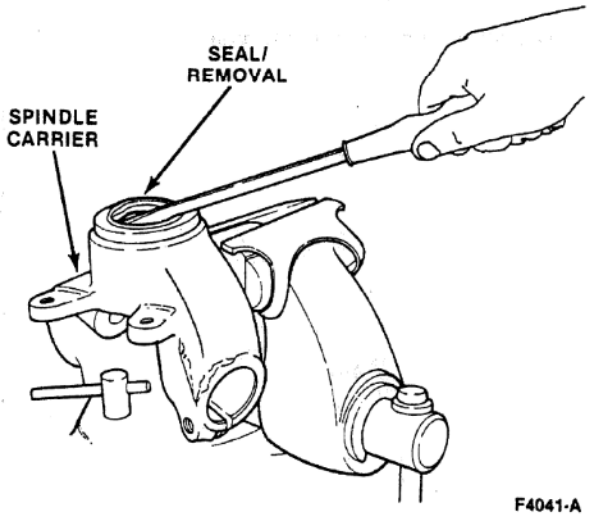
4. Lift the spindle carrier and inner bearing off the spindle shaft. Remove the inner bearing and splined washer.

   If the bearing will be reused, tag it so that it can be installed in its original position.

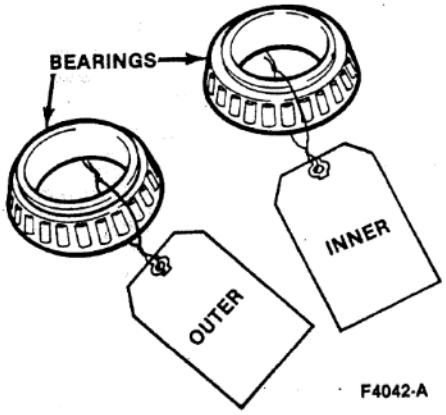




5. Clamp the spindle carrier in the vise and remove the grease seal using a large screwdriver.



6. Remove the outer bearing from the spindle carrier. If the bearing will be re-used, tag it so that it can be installed in its original position.

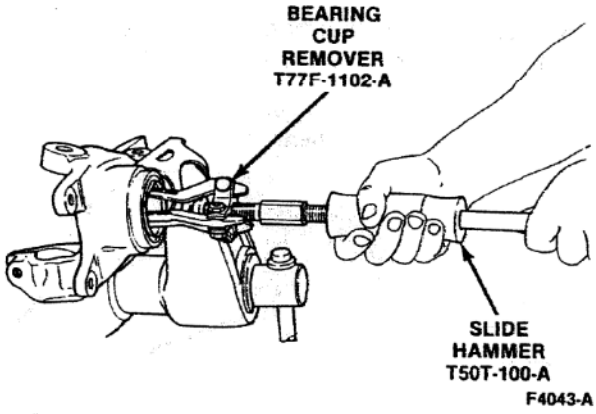


DISASSEMBLY AND ASSEMBLY

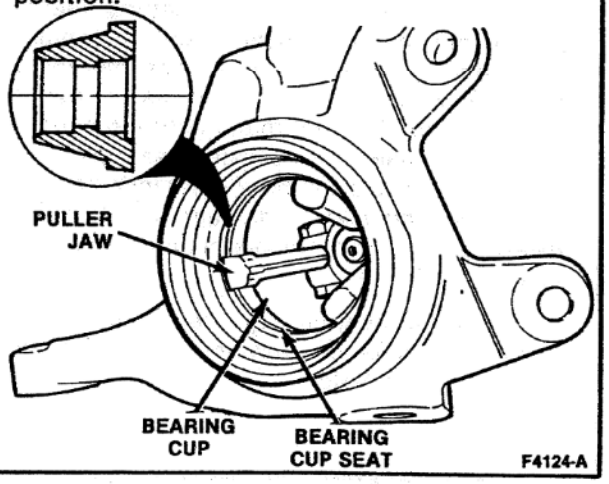
SPINDLE CARRIER

Disassembly (Continued)

7. Remove the bearing cups using Bearing Cup Remover T77F-1102-A and Slide Hammer T50T-100-A or equivalents.



NOTE: When removing the remaining bearing cup, make sure the puller jaws do not catch against the bearing cup seat in the center of the hub. Also, use care to prevent burring the bearing race seat. A burr may prevent proper seating of the bearing race during assembly. If the bearing cups will be re-used, tag them so that they can be installed in their original position.



FRONT WHEEL BEARINGS AND SPINDLE CARRIERS COMPONENT INSPECTION CHART

NOTE: Thoroughly clean all parts in solvent and blow dry with compressed air. If the bearings are dried with compressed air, do not allow the bearings to spin. Turn them slowly by hand. Spinning bearings may damage the rollers.

COMPONENT	CHECK FOR
SPINDLE CARRIER	• Damaged caliper anchor bolt threads • Damaged spindle carrier pinch bolt threads • Evidence that the bearing races have "spun" in the carrier • Elongated or worn taper at the lower control arm and steering tie rod joints • Wear or damage at suspension strut seat • Cracks in the spindle carrier casting • Damaged grease seal seat
FLANGE SHAFT	• Damaged or loose wheel studs • Worn or scored bearing surfaces • Damaged spindle bearing lock nut threads • Evidence that the bearings have "spun" on the shaft • Pitted or scored seal surface
BEARINGS	• Refer to the Bearing Inspection Chart at the end of this group. **NOTE:** Always replace both spindle bearings and cups as a matched set. (CF4044-A)

DISASSEMBLY AND ASSEMBLY

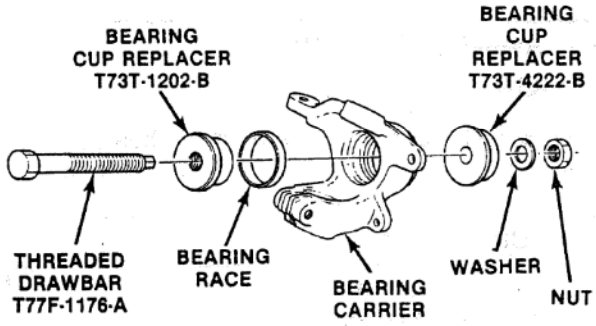
SPINDLE CARRIER

Assembly

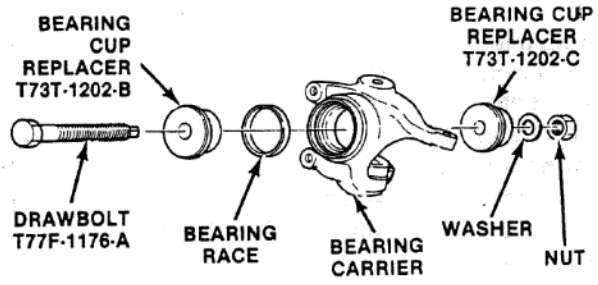
NOTE: During manufacture, the spindle bearings and spindle shafts are precision-machined to produce close tolerance fits. This allows the bearings to be self-setting and non-adjustable. The necessary running clearance and bearing preload achieved by this self-setting feature can be duplicated in service **only** if replacement bearings meet the same close tolerances. Bearings which are about the same size or bearings from different manufacturing sources **must not be used.** Use of such bearings could cause excessive preload or clearance and premature bearing wear. If damage should occur, always replace both spindle bearings and cups as a matching set.

1. Install the bearing cups using the Special Service Tools, or equivalents, shown in the illustrations below.

INNER BEARING CUP INSTALLATION



OUTER BEARING CUP INSTALLATION



MAKE SURE THE BEARING RACES ARE FULLY SEATED IN THE SPINDLE CARRIER.

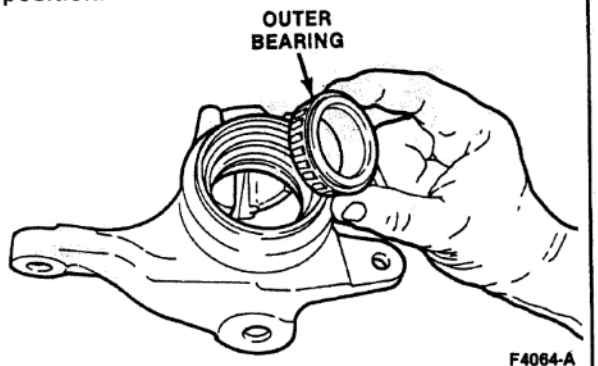
F4046-A

2. Pack the spindle bearings with Lubricant C1AZ-1959D-B, C, D or E or equivalent.

NOTE: Do not pack the space between the bearings in the spindle carrier. Overpacking can result in grease leakage.

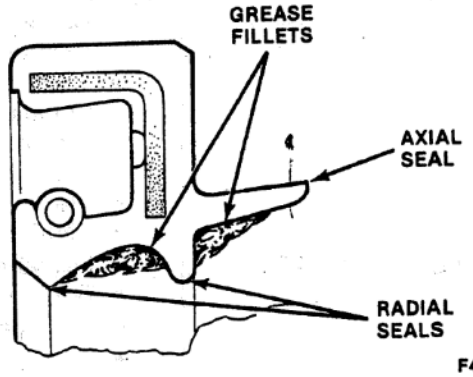
3. Install the outer bearing in the spindle carrier.

NOTE: If the original bearings are being used, make sure they are installed in their original position.



F4064-A

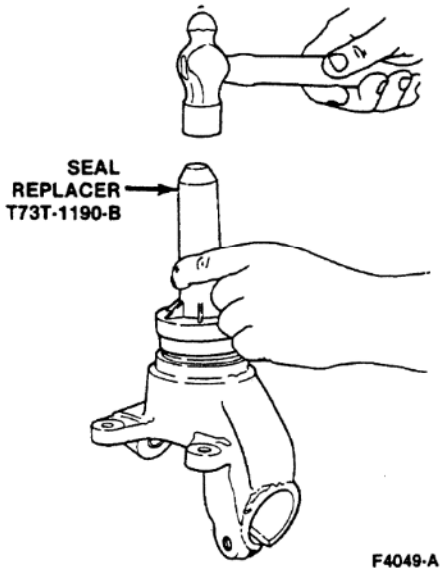
4. Lubricate the grease seal lips with Lubricant C1AZ-19590-B, C, D or E or equivalent. Form the lubricant into a fillet along the seal lip edges.



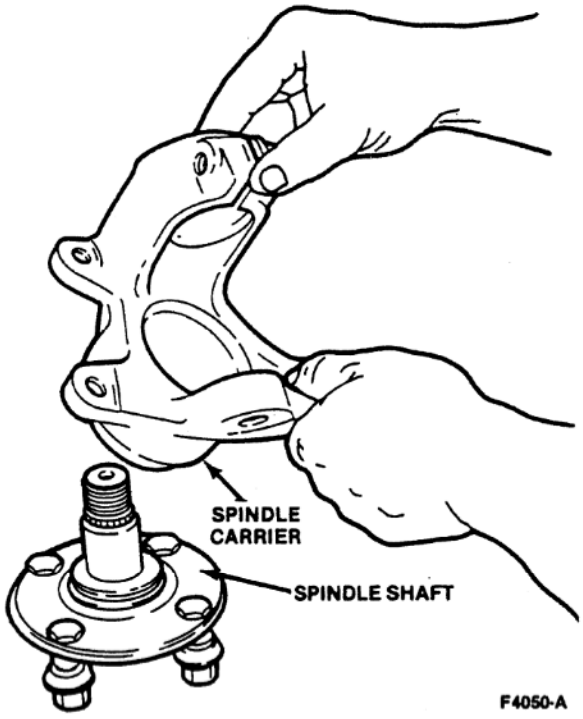
F4048-A

DISASSEMBLY AND ASSEMBLY (Continued)

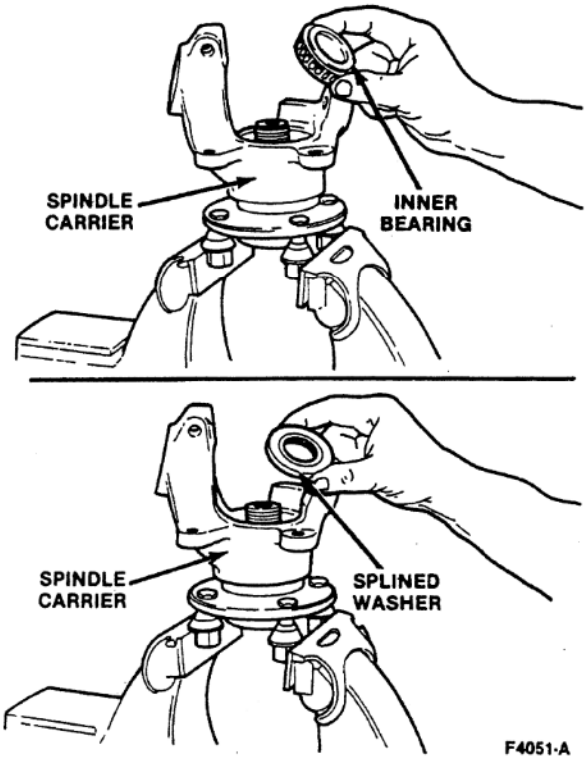
5. Install a new grease seal using Seal Replacer T73T-1190-B or equivalent.



6. Be sure the spindle shaft is clean and install the spindle carrier over the shaft.

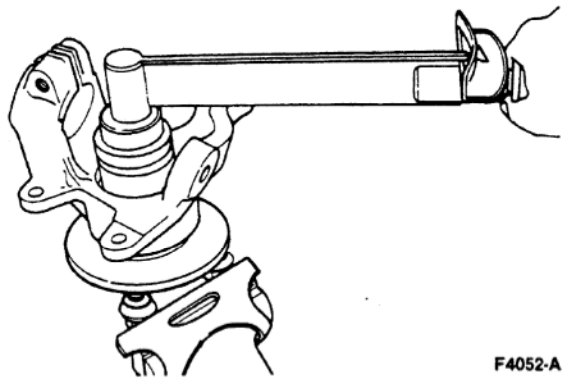


7. Install the inner bearing and splined washer.



8. Install the spindle bearing locknut and tighten to 310 to 350 N·m (229 to 250 lb-ft).

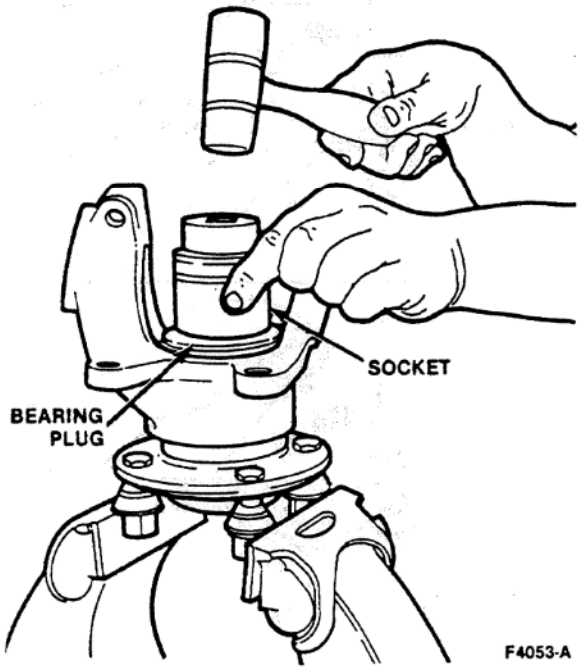
CAUTION: The amount of torque on the spindle bearing locknut is extremely important. If a higher or lower torque is applied to the locknut, premature bearing failure can result. Be sure the locknuts are tightened to the specified torque with a properly calibrated torque wrench.



DISASSEMBLY AND ASSEMBLY (Continued)

NOTE: If the spindle carrier is from the left side of the vehicle, turn the nut clockwise to tighten. If the spindle carrier is from the right side, turn the nut counterclockwise to tighten.

9. Install the bearing plug.



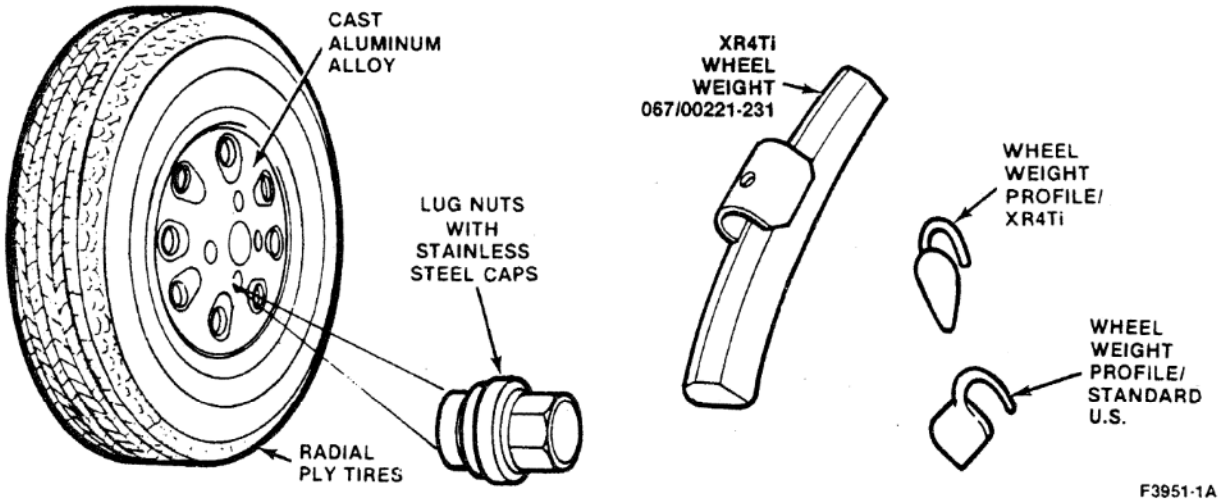
10. Remove the lug nuts from the wheel studs.

SECTION 11-17 Wheels And Tires

SUBJECT	PAGE
DESCRIPTION	
General Information	11-17-1
MAINTENANCE	
Cleaning	11-17-3
Tire Inflation Pressures	11-17-4
Tire Rotation	11-17-5
Tire Service Puncture Repair	11-17-5
REMOVAL AND INSTALLATION	
Wheel and Tire Assembly	11-17-6
Wheel Stud	11-17-6
TEMPORAL SPARE	11-17-3
TIRE SIZE	11-17-2

DESCRIPTION

General Information



The XR4Ti is equipped with Pirelli P-6 radial-ply tires as standard equipment. The tires are a European metric size and should not be confused with the "P" size metric tires available in North America.

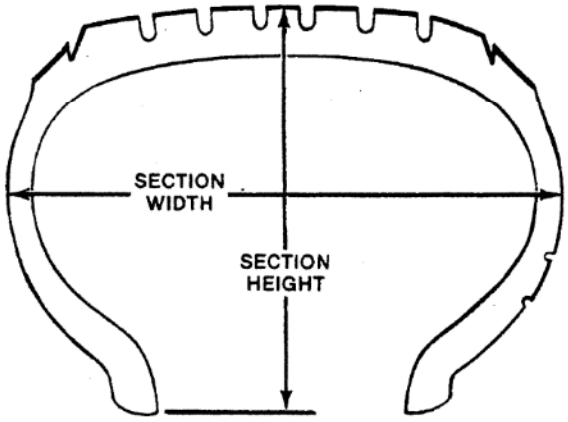
The tires are mounted on 5.5 inch cast aluminum alloy wheels. The wheels have an "as cast" surface with no machining and therefore no sharp-corners or edges. The surface has a three-coat paint system with excellent corrosion resistance. Take care when handling the wheel so you do not chip or scratch the finish. The wheels must **not** be cleaned with abrasive materials.

The stainless steel capped lug nuts are designed specifically for use with the aluminum wheel. A conventional steel wheel lug nut is a single piece with one end tapered to form a cone shape. It is the cone-shaped end that seats against the wheel when the lug nut is tightened. With a cast aluminum wheel, however, the lug nut hex and cone shape are separate pieces of a common sleeve. This arrangement allows the hex to rotate on the sleeve while the cone is held stationary. When the lug nut is installed, the cone will stop turning when it contacts the wheel. The hex, however, continues to turn until tightened to the specified torque. If the harder steel cone did not stop rotating upon contact with the wheel it could "dig" into the softer aluminum alloy.

TIRE SIZE

XR4Ti METRIC TIRE SIZE

195	60	H	R	14 (85/86) 15 (87/88)
SECTION WIDTH (MILLIMETERS)	ASPECT RATIO (SECTION HEIGHT) (SECTION WIDTH)	SPEED RATING H = UP TO 210 KPH (130 MPH)	CONSTRUCTION TYPE R—RADIAL	RIM DIAMETER (INCHES)



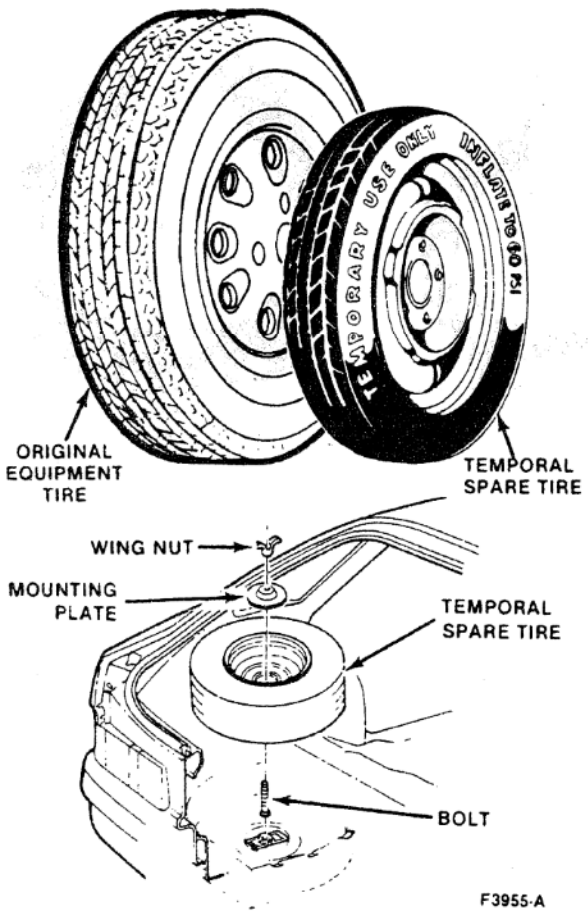
F3953-B

The tire size is imprinted on the tire sidewall. An explanation of the XR4Ti tire size code is provided in the illustration. The XR4Ti is equipped with standard-load tires.

Replacement tires should be of the same size, load range, and construction as those originally on the vehicle. If metric tires must be replaced with other sizes, as in the case of snow tires, consult a tire dealer. Tire companies can best recommend the closest match of alpha to metric sizes within their own tire lines.

Replacement wheels must be equivalent to the original equipment wheels in load capacity, diameter, rim width, offset, and mounting configuration. A wheel of improper size or type may affect wheel and bearing life, brake cooling, speedometer/odometer calibration, ground clearance, and tire clearance to the body and chassis.

TEMPORAL SPARE



A high-pressure mini-spare tire—called the temporal spare—is standard on the XR4Ti. The tire is located in a well below the luggage compartment floor. The floor cover is lifted and folded back to gain access to the spare tire. The jack is mounted behind the carpet trim located just below the liftgate latch.

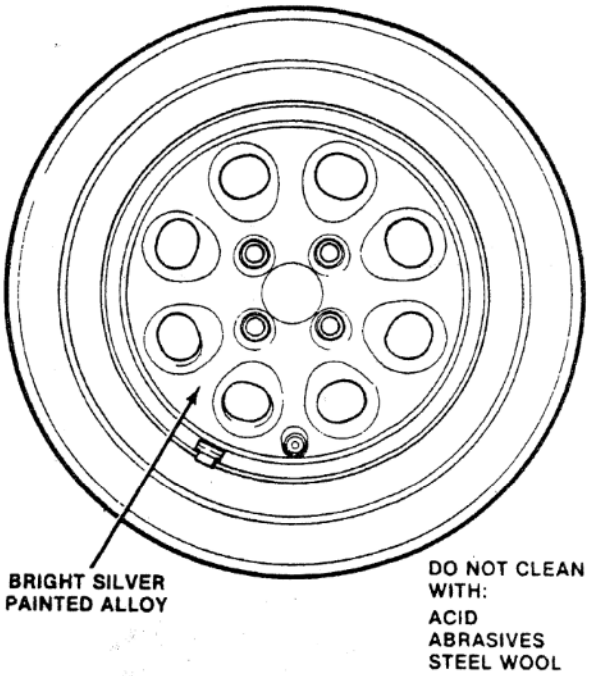
The temporal spare is a unique narrow-profile spare tire. It is designed to operate at an inflation pressure of 415 kPa (60 psi) and is mounted on a special wheel. The tire is air-inflated using standard inflation equipment. Special inflation methods are not required.

WARNING: TO GUARD AGAINST BODILY INJURY, USE CAUTION WHEN INFLATING OR ADDING AIR TO THE TEMPORAL SPARE. USE A 689 KPA (100 PSI) CAPACITY PRESSURE GAUGE ONLY TO CHECK INFLATION PRESSURE AND INFLATE THE TIRE TO A MAXIMUM OF 415 KPA (60 PSI). WHEN INFLATING THE TIRE, ADD AIR IN VERY SMALL AMOUNTS ONLY AND CHECK PRESSURE FREQUENTLY AS SMALL AMOUNTS OF AIR WILL INCREASE PRESSURE SEVERAL PSI.

- Do not use the temporal spare tire for extended mileage or for speeds above 80 km/h (50 mph).
- Do not use temporal spare for tire rotation.
- Do not attempt to service or remove the temporal spare from its wheel.
- Do not attempt to use the wheel for any other type of tire.

MAINTENANCE

Cleaning

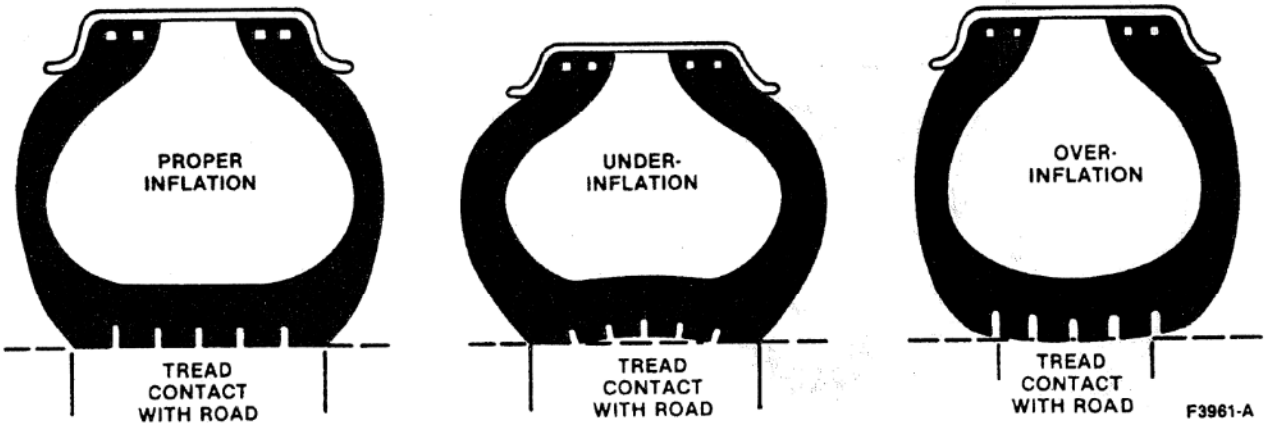


The XR4Ti vehicle is equipped with bright silver painted (basecoat and clearcoat) alloy wheels.

Do not use aluminum wheel cleaners or other cleaners containing ACID and/or ABRASIVES. They will destroy the clear protective coating and allow the exposed aluminum to corrode. Wash with Ford Wash and Wax Concentrate, or equivalent, properly diluted, and rinse with clear, cold water. DO NOT use steel wool or other abrasive cleaning pads.

MAINTENANCE (Continued)

Tire Inflation Pressures



XR4Ti — RECOMMENDED TIRE SIZE AND INFLATION PRESSURE (COLD) — **1**

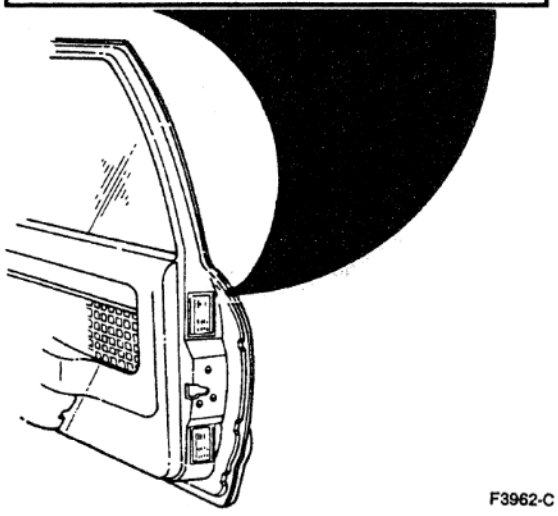
TIRE SIZE	VEHICLE LOAD	PRESSURE FRONT	PRESSURE REAR
195/60 HR14* 85/86 195/60 HR15 87/88	LIGHT	26 PSI 180 kPa	26 PSI 180 kPa
195/60 HR14* 85/86 195/60 HR15 87/88	MAXIMUM	32 PSI 221 kPa	32 PSI 221 kPa
T115/70D15 TEMPORAL SPARE	T	60 PSI 415 kPa	60 PSI 415 kPa

*MUST BE REPLACED WITH AN EQUIVALENT TYPE SPEED RATED TIRE.

ALL MODELS	LIGHT LOAD 750 lb./340 kg.	TOTAL OCCUPANTS	4: 2 FRONT 2 REAR	LUGGAGE 150 lb./68 kg.
ALL MODELS	MAXIMUM LOAD 900 lb./408 kg.	TOTAL OCCUPANTS	5: 2 FRONT 3 REAR	LUGGAGE 150 lb./68 kg.

FOR SUSTAINED HIGH SPEED, TRAILER TOWING, RECREATIONAL ACCESSORIES AND TEMPORAL SPARE USAGE—SEE OWNER'S GUIDE

▽ ESRD-1532-AC



kPa	psi	kPa	psi
140	20	215	31
145	21	220	32
155	22	230	33
160	23	235	34
165	24	240	35
170	25	250	36
180	26	275	40
185	27	310	45
190	28	345	50
200	29	380	55
205	30	415	60

CONVERSION: 6.9 kPa = 1 psi CF3963-A

The tire inflation pressure is carefully calculated to give the vehicle satisfactory ride and steering characteristics while not compromising long tire tread life. The recommended vehicle load capacities and tire inflation pressures are listed on a label attached to the inside edge of the passenger door.

Check and adjust tire inflation pressures only when the tires are cold (vehicle has been parked for 3 hours or more) or driven for less than 3.2 km (2 miles) at speeds below 64 km/h (40 mph).

Do not reduce inflation pressures if the tires are hot, or driven over 3.2 km (2 miles) at speeds above 64 km/h (40 mph) as pressures can increase as much as 41 kPa (6 psi) over cold inflation pressures.

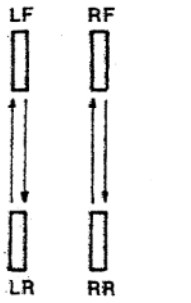
Be sure to reinstall the valve cap. It prevents air leaks and keeps dust out of the valve.

MAINTENANCE

TIRE ROTATION

TIRE ROTATION DIAGRAM
RADIAL PLY TIRES

4 TIRE ROTATION



F2976-B

Periodic rotation of the tires can help equalize tire wear and extend tread wear life. Tire rotation will not correct the cause of abnormal or excessive tire wear. Before rotation, inspect each tire for wear patterns that may indicate a problem. If tire wear pattern appears uneven or excessive for the amount of mileage, refer to Section 11-01 for further inspection and diagnostic procedures.

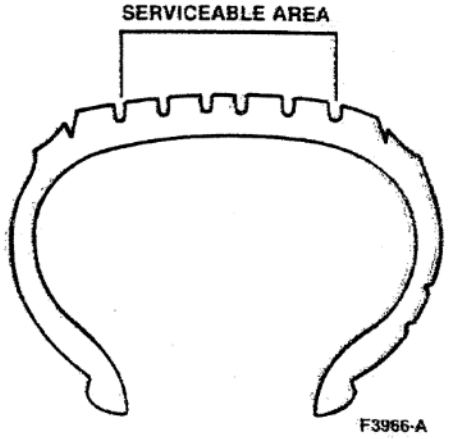
The XR4Ti is equipped with radial-ply tires that must be rotated in a front-to-back pattern. Use of the "X" pattern on radial-ply tires can result in roughness and irregular wear. After rotation check and, if necessary, adjust the tire pressure to the proper level.

CAUTION: The XR4Ti is equipped with a temporal spare tire. Do not include it in the rotation of the other four tires.

Wheel lug nut torque ..... 70–100 N·m (55–70 lb-ft)

Tire inflation pressures ..... Refer to the tire inflation decal

TIRE SERVICE PUNCTURE REPAIR



F3966-A

Punctured tires should be removed from the wheel and permanently serviced from the inside using a combination service plug and vulcanizing patch. When servicing a puncture, always follow the manufacturer's instructions for using the service kit.

Punctures in the tread area only are serviceable. Never attempt to service punctures in the tire shoulders or sidewalls. In addition, do not service any tire that has sustained the following damage:

- Bulges or blisters
- Ply separation
- Broken or cracked beads
- Fabric cracks or cuts
- Tires worn to the fabric, or wear indicators visible
- Punctures larger than 1/4-inch diameter.

WARNING: Tire sealants that are injected through the valve stem are not to be used to service punctured tires because they can produce wheel corrosion and tire imbalance.

Use a Rotunda Tire Changer or equivalent to mount or demount tires. Follow the equipment manufacturer's instructions. Do not use hand tools or tire irons alone to change a tire because they may damage the tire beads or wheel rim.

MAINTENANCE

TIRE SERVICE PUNCTURE REPAIR (Continued)

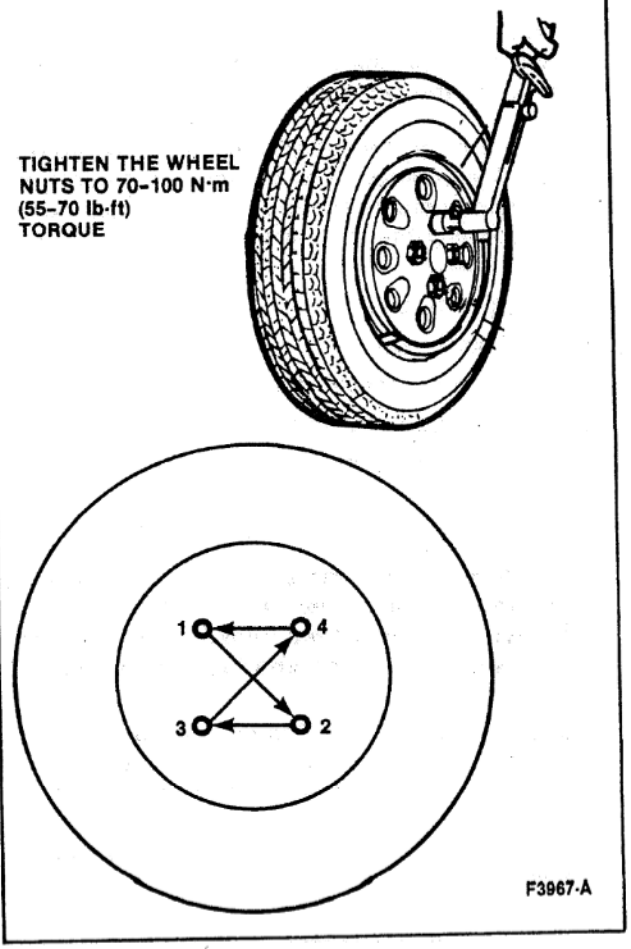
NOTE: The polished surface on the aluminum alloy wheel is protected from corrosion by a three-coat paint system. When handling the wheel, use care to prevent scratching or nicking the lacquer coating.

Aluminum wheel rim bead seats should be cleaned with a non-abrasive cleaner to remove the mounting lubricants and old rubber. Before mounting or demounting a tire, the bead area should be well lubricated with D9AZ-19583-A or equivalent tire lubricant.

After mounting, inflate the tire, so its beads are completely seated. Install the valve core. Inflate the tire to the proper pressure.

REMOVAL AND INSTALLATION

WHEEL AND TIRE ASSEMBLY



Removal

1. Loosen the wheel lug nuts one turn.
2. Raise the vehicle.
3. Remove the lug nuts and the wheel/tire assembly.

Installation

1. Install the wheel/tire assembly and the lug nuts.

   Snug but do not tighten the lug nuts.
2. Lower the vehicle.
3. Tighten the lug nuts to 70-100 N·m (55-70 lb-ft) in the sequence shown.

The lug nuts must be tightened in sequence and to the proper torque to avoid bending the wheel, brake drum or rotor.

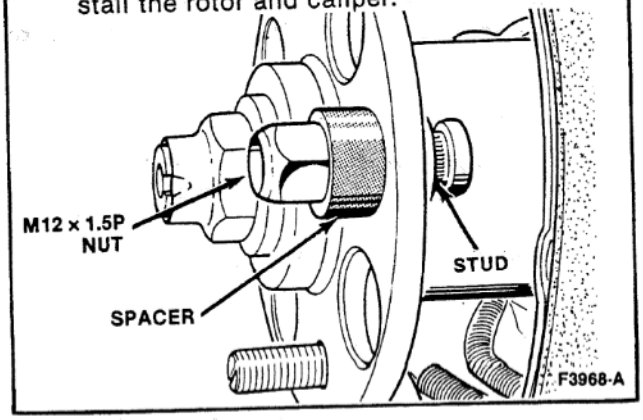
WHEEL STUD

Removal

1. Remove the wheel and brake drum. On the front, remove the caliper and rotor.
2. Drive the stud out of the driveshaft flange.

Installation

1. Position the stud in the flange.
2. Install a suitable spacer or a stack of washers over the stud.
3. Using a M12 x 1.5P nut, pull the stud into the flange.
4. Install the drum and wheel. On the front, install the rotor and caliper.



Group 11 Specifications

TIRE SIZE: 195/60 HR 15 1987/88
195/60 HR 14 1985/86

195 = section width
60 = aspect ratio
H = speed rating—209 kph (130 mph)
R = construction—steel belted radial
14/15 = rim diameter

RUNOUT (Same for 14 and 15 inch wheel)

Wheel and Tire

- Radial 1.6mm (0.063 inch)
- Lateral 1.8mm (0.071 inch)

Wheel Only

- Radial 0.4mm (0.016 inch)
- Lateral 0.5mm (0.019 inch)

TIRE PRESSURES:

XR4Ti	RECOMMENDED TIRE SIZE AND INFLATION PRESSURE (COLD)	1

TIRE SIZE	VEHICLE LOAD	PRESSURE FRONT	PRESSURE REAR
195/60 HR14* 85/86 195/60 HR15 87/88	LIGHT	26 PSI 180 kPa	26 PSI 180 kPa
195/60 HR14* 85/86 195/60 HR15 87/88	MAXIMUM	32 PSI 221 kPa	32 PSI 221 kPa
T115/70D15 TEMPORAL SPARE	T	60 PSI 415 kPa	60 PSI 415 kPa

*MUST BE REPLACED WITH AN EQUIVALENT TYPE SPEED RATED TIRE.

ALL MODELS	LIGHT LOAD 750 lb./340 kg.	TOTAL OCCUPANTS	4: 2 FRONT 2 REAR	LUGGAGE 150 lb./68kg.
ALL MODELS	MAXIMUM LOAD 900 lb./408 kg.	TOTAL OCCUPANTS	5: 2 FRONT 3 REAR	LUGGAGE 150 lb./68 kg.

FOR SUSTAINED HIGH SPEED, TRAILER TOWING, RECREATIONAL ACCESSORIES AND TEMPORAL SPARE USAGE—SEE OWNER'S GUIDE. ▽ E5RD-1532-AC

F5677-B

WHEEL BEARING LUBRICANT: C1AZ-1959DB, C, D or E, or equivalent meeting Ford specification ESAM 1C 198A

TORQUE CHART

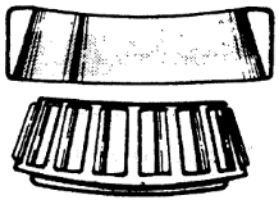
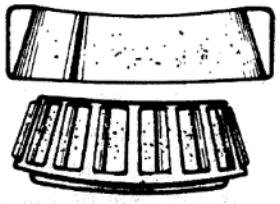
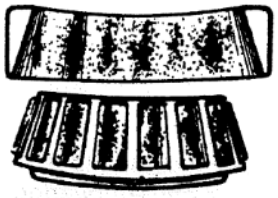
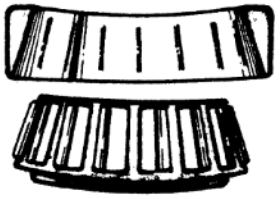
ITEM	N·m	lb-ft
Wheel lug nuts	100-144	75-101
Rear hub bolts	52-64	45-48
Wheel flange nut	310-350	229-250
Strut pinch bolt	80-90	59-66
Lower control arm ball joint nut*	65-85	48-65
Tie rod end ball joint nut*	25-30	18-22
Spindle bearing locknut	310-350	229-250

CAUTION: The amount of torque on the spindle bearing locknut is extremely important. If a higher or lower torque is applied to the locknut, premature bearing failure can result. Be sure the locknuts are tightened to the specified torque with a property calibrated torque wrench.

***NOTE:** If the slots in the nut do not align with the cotter pin hole, tighten the nut to the next slot. Never loosen the nut for alignment.

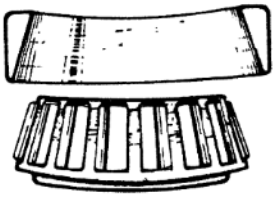
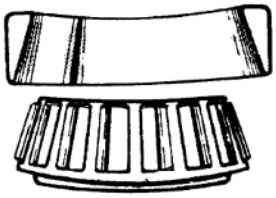
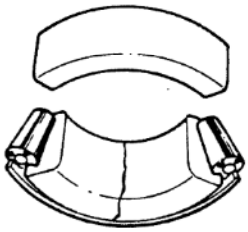
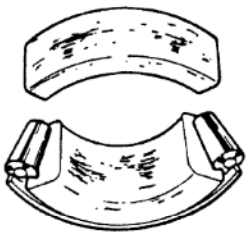
BEARING INSPECTION CHART

REAR WHEEL BEARINGS AND HUBS
COMPONENT INSPECTION CHART (Continued)
—BEARINGS—

CONDITIONS	CAUSE	CORRECTION
MISALIGNMENT 	• Bearing cup misaligned in spindle bore due to burr, nick or dirt on cup seat	• Replace bearings • Inspect bearing cup seats for damage or dirt
INDENTATIONS 	• Contaminated lubricant	• Replace bearings
FATIGUE SPALLING (Flaking or surface metal) 	• Excessive preload • Insufficient lubricant • Incorrect lubricant	• Replace bearings • Use only specified lubricant
BRINELLING (Surface indentations in raceway) 	• Impact loading or vibration while the bearings is not rotating • Insufficient lubricant	• Replace bearings if rough or noisy

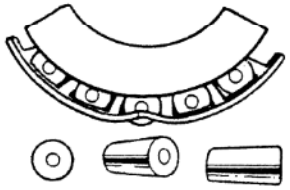
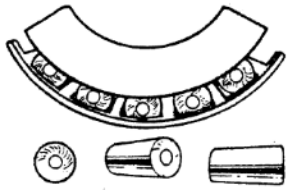
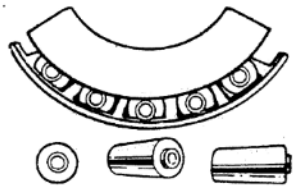
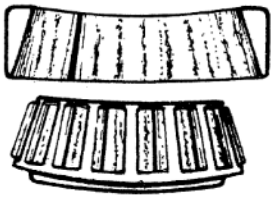
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REAR WHEEL BEARINGS AND HUBS
COMPONENT INSPECTION CHART (Continued)
—BEARINGS—

CONDITIONS	CAUSE	CORRECTION
CAGE WEAR 	• Fine abrasives mixed with lubricant • Insufficient lubricant	• Replace bearings • Use only specified lubricant
ABRASIVE ROLLER WEAR 	• Fine abrasives mixed with lubricant	• Replace bearings if rough or noisy
CRACKED INNER RACE 	• Improper fit • Misaligned bearing cup • Metal chips	• Replace bearings • Use correct bearing • Inspect bearing cup seats for damage or dirt
SMEARS (Smearing of metal due to slippage) 	• Improper fit • Incorrect lubricant • Overheating • Excessive loading	• Replace bearings • Use correct bearings • Use only specified lubricant

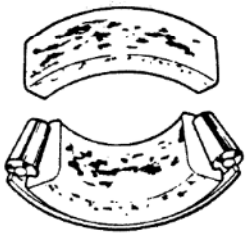
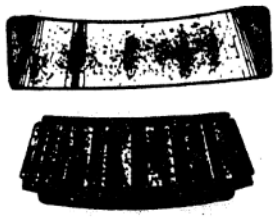
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REAR WHEEL BEARINGS AND HUBS COMPONENT INSPECTION CHART —BEARINGS—

CONDITION	CAUSE	CORRECTION
BENT CAGE 	• Improper handling or tool usage	• Replace bearings
GALLING (Metal Smears on roller ends) 	• Overheating • Lubricant failure • Incorrect lubricant • Lubricant failure	• Replace bearings • Use only specified lubricant
ABRASIVE STEP WEAR 	• Fine abrasives mixed with lubricant	• Replace bearings
ETCHING (Bearing surfaces appear gray or grayish black in color. Etching of bearing material may occur between the rollers) 	• Incorrect lubricant • Lubricant failure	• Replace bearings • Use only specified lubricant

CF4045

REAR WHEEL BEARINGS AND HUBS
COMPONENT INSPECTION CHART (Continued)
—BEARINGS—

CONDITION	CAUSE	CORRECTION
FRETTAGE 	• Corrosion set up by small relative movement between bearing rollers, races and cups without adequate lubrication	• Replace bearings
HEAT DISCOLORATION (Color can range from faint yellow to dark blue) 	• Excessive loading • Incorrect lubricant • Insufficient lubricant • Improper fit • Excessive preload	• Replace bearings • Use only specified lubricant • Use correct bearings
STAIN DISCOLORATION (Color can range from light brown to black) 	• Incorrect lubricant • Moisture contamination	• Reuse bearings if stains can be removed by light polishing or if no evidence of overheating is observed • Use only specified lubricant

CF4045-A

BRAKES

GROUP 12 (2000)

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- Troubleshooting Chart—Master Cylinder 11
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ADJUSTMENTS

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Parking Brake Lever 6

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Pressure Control Valve 4
Brake Pedal 4
Caliper Hose 6

DISASSEMBLY AND ASSEMBLY

Master Cylinder 8
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GROUP 12

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BRAKES 12

(2000)

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SECTION 12-01 Brake System Diagnosis

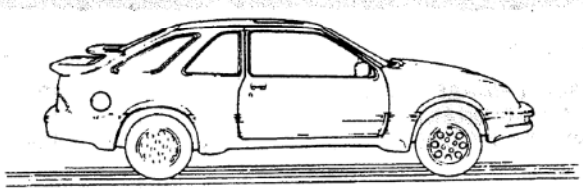
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ROAD TEST

A road test is performed to compare actual vehicle braking performance with the performance standards expected by the driver. The ability of the test driver to make valid comparisons and detect performance deficiencies will depend—in large part—on the experience of the test driver. This experience has to include a thorough knowledge of brake system operation, acquired general performance guidelines and the ability to recognize brake performance that is characteristic of the vehicle being tested.

ROAD TEST (Continued)

An experienced brake technician will always establish a route that will be used for all brake diagnosis road tests. The road selected will be reasonably smooth and level. Gravel or bumpy roads are unsuitable because the surface does not allow the tires to grip the road equally. Crowned roads are avoided because of the large amount of weight shifted to the low set of wheels on this type of road. Once the route is established and consistently used, the road surface variable is eliminated from the test results.



ALWAYS ROAD-TEST ON SMOOTH, UNCROWNED ROADS

H5267

Before a road test, get a complete description of the customer complaint or suspected condition. From the description, experience will begin to match possible causes with symptoms. Certain components will be tagged as possible suspects while others are eliminated by the evidence. More importantly, the description can uncover unsafe conditions which should be checked or corrected before the road test. The description will also help form the basic approach to the road test by narrowing the problem to specific components, vehicle speed or conditions.

Begin the road test with a general brake performance check. Keeping the description in mind, test the brakes at different vehicle speeds using both light and heavy pedal pressure. To determine if the problem is in the front or rear brake system, first use the service brake pedal then the parking brake. If the condition (i.e., pull, vibration, pulsation) occurs only with the hand brake, the problem is in the rear system. If the condition occurs when the service brake pedal is pressed, the problem is in the front system.

Avoid locking the brakes and sliding the tires. Locked brakes and sliding tires do not indicate brake efficiency. A heavily braked, but turning wheel, will stop the vehicle in less distance than locked brakes. If the problem becomes evident during this check, make sure it fits the description given before the road test. If the problem is not evident, attempt to duplicate the condition using the information from the description.

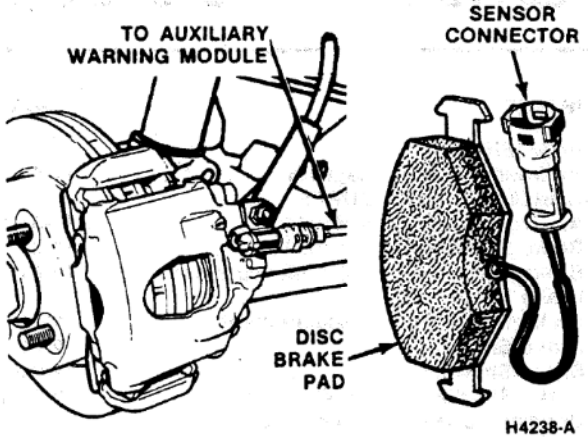
If a problem exists, use the Troubleshooting Chart to isolate it to a specific subsystem and condition description. From this description, a source list of possible causes can be used to further narrow the cause to a specific component or condition.

VISUAL INSPECTION

Disc Brakes

Inspection

The front disc brakes are equipped with wear sensors that will illuminate an indicator light in the instrument panel when either inboard brake pad has worn to a thickness of 1.5mm. If the light is on, remove the front wheels and check the pad thickness. Worn pads must be replaced. If the pads are not worn, check for a problem in the indicator light circuit.



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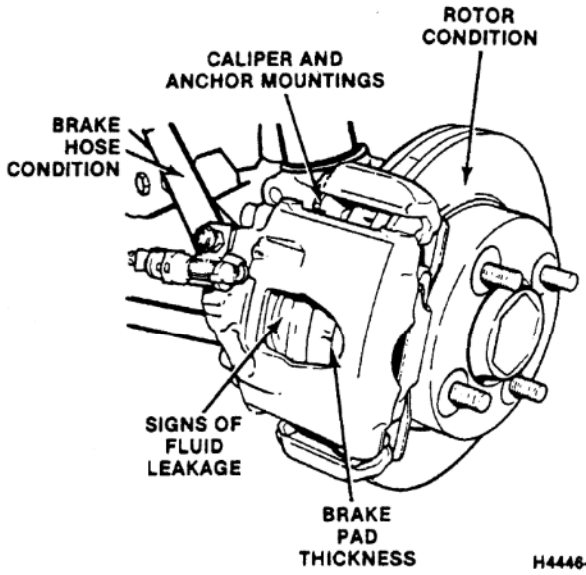
Whenever the pads are inspected, check for brake fluid contamination which might indicate a leaking caliper seal. If a seal is leaking, the caliper must be disassembled and inspected. If necessary, refer to Section 12-20.

Check for even wear from side to side. If the set of pads on one side of the vehicle is excessively worn, the caliper piston may be seized in the bore. If a seized piston is suspected, the caliper must be disassembled and inspected. If necessary, refer to Section 12-20.

VISUAL INSPECTION (Continued)

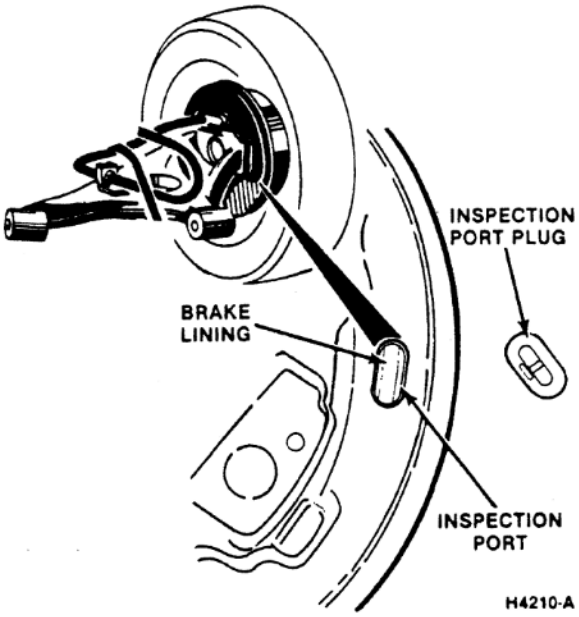
Inspect the caliper and caliper mounting for loose or damaged parts. Make sure the caliper and anchor attaching bolts are tightened to the specified torque. The anti-rattle spring should be tight against the brake without signs of distortion or lack of tension.

Check the brake hose and caliper fitting for leaks or damage. Carefully check the caliper for wet areas that might indicate a leaking caliper seal. Unless the damage is obvious, a visual inspection of the rotor will not determine the required rotor service—resurface, recondition or replace. Tolerances on rotor thickness, parallelism, and runout are very critical and must be measured with precision tools. Use the Brake Rotor Troubleshooting Chart in Section 12-20 as a guide for visual inspection and necessary measurements.



Drum Brakes

Inspection



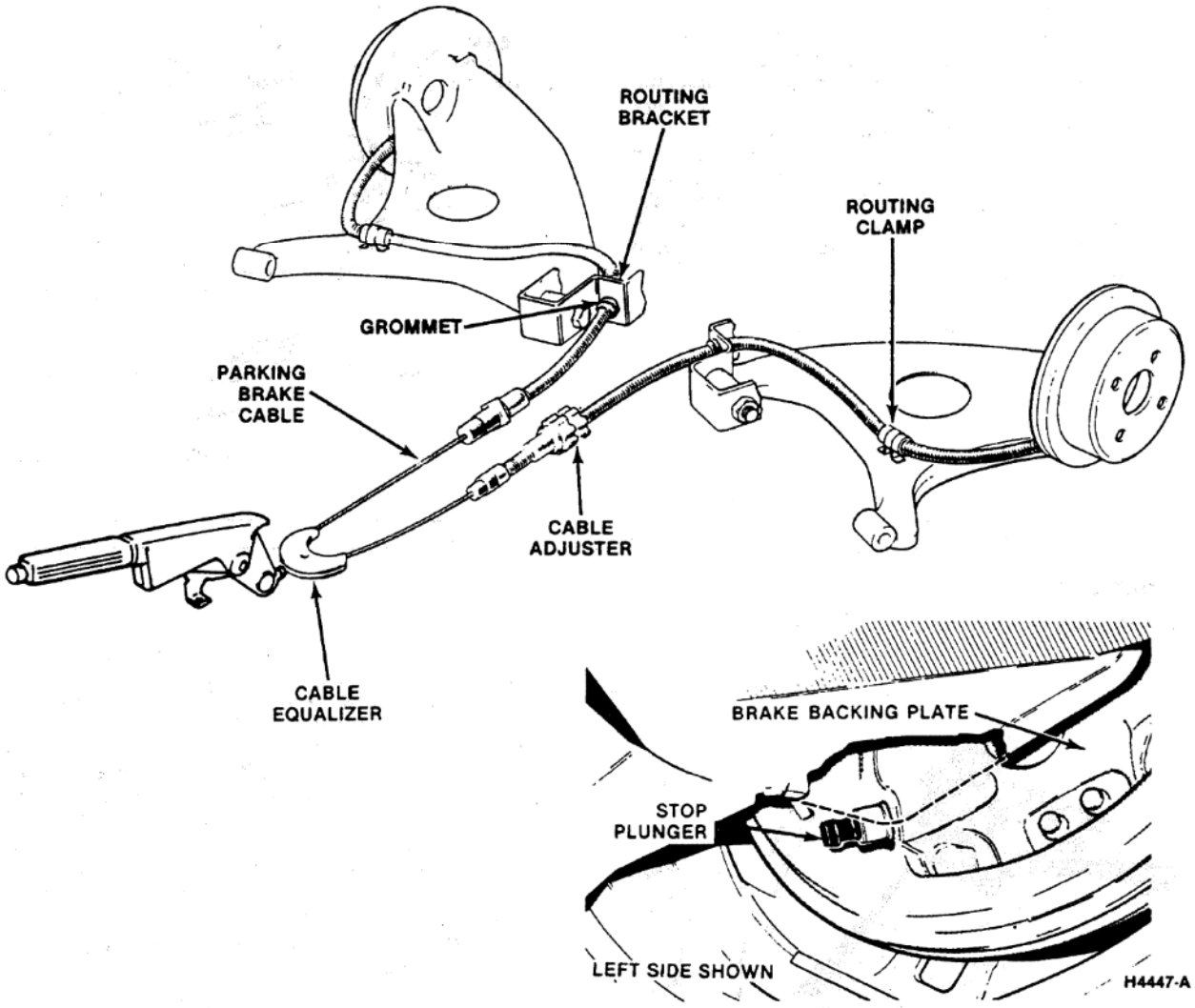
A small port is provided in each backing plate to allow inspection of brake lining thickness without removing the brake drums. Looking at the backing plate from under the vehicle, the ports are located at approximately the two o'clock position (left) and the eleven o'clock position (right). The ports are sealed with a plastic plug to prevent the entry of dirt and moisture. With the plug removed, the lining on the primary shoe can be seen with the aid of a small light. The primary lining is inspected because it normally wears at a more rapid rate than the secondary lining.

If the brake lining thickness is less than 1.0mm (.040 in.), replace the linings.

VISUAL INSPECTION (Continued)

Parking Brake

Inspection



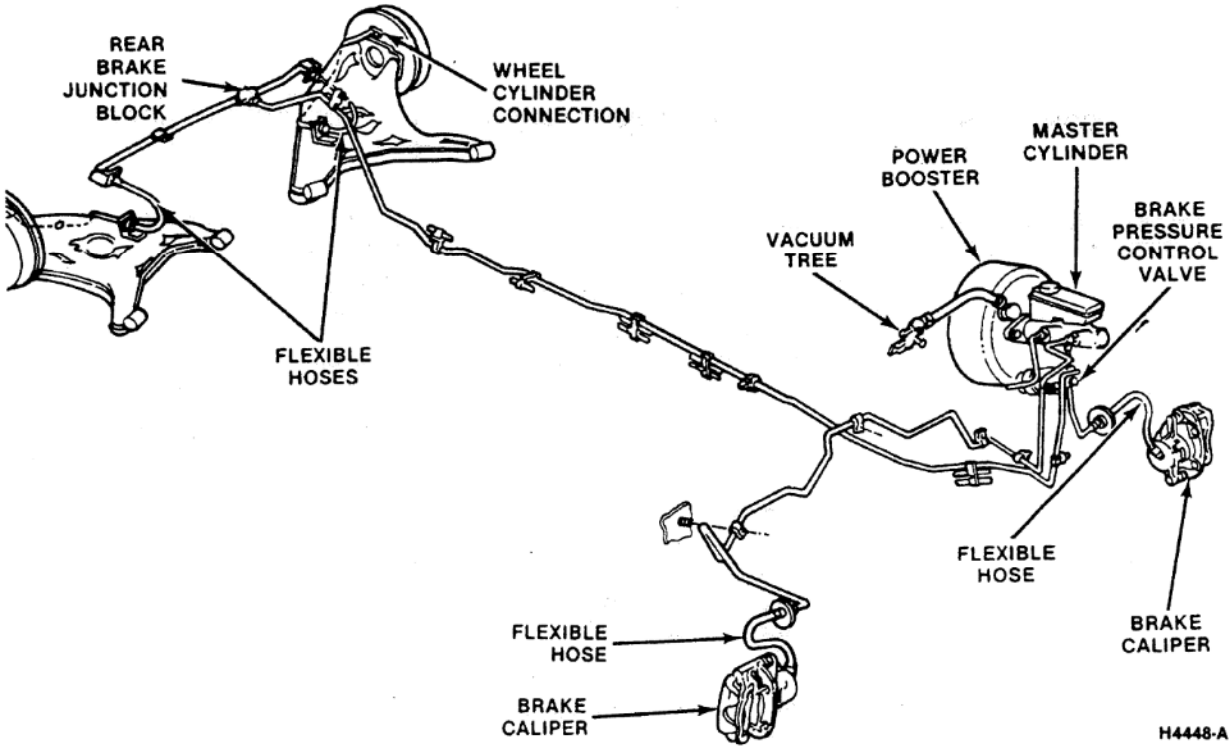
Check the parking brake cable for damage and proper routing. If the cable is damaged it should be replaced. If necessary, refer to Section 12-70. Operate the parking brake lever and check for any conditions that may cause binding and incomplete release of the parking brake. If the parking brake components are in good condition, check the cable adjustment.

Parking brake stop plungers are installed in both rear brake backing plates. These plungers are used to determine if the parking brake cable is properly adjusted. Looking at the backing plates from under the vehicle, the plungers are located at approximately the seven o'clock position (left) and five o'clock position (right). To check the cable adjustment, push the brake pedal several times to make sure the self-adjuster is set, make sure the parking brake lever is fully released and then check the amount of movement at the stop plungers. When added together, the total movement of the plungers should not exceed 4mm (.16 in.). If the plunger movement is more or less than specified, the parking brake should be adjusted. If necessary, refer to Section 12-70.

VISUAL INSPECTION (Continued)

Hydraulic System

Inspection



An inspection of the brake hydraulic system begins with a fluid level check at the master cylinder. If the fluid level is below the line in the reservoir, add the required amount of fluid. Make sure the brake fluid meets specifications. While in the master cylinder area, check the brake lines and master cylinder mounting. The brake lines and attaching nuts must be tight. The brake line fittings must not show any signs of leakage.

The following conditions are considered normal and are not indications that the master cylinder is in need of service.

Condition 1—Low fluid level without signs of leakage. This condition is caused by displacement of fluid from the reservoir into the calipers to compensate for normal lining wear. Top off the reservoir.

Condition 2—A momentary or slight squirt of brake fluid from the master cylinder reservoir upon application of the brake pedal. This condition is caused by the fluid displacement through the reservoir compensating port as the master cylinder pistons move forward in the bore when the brakes are applied.

Condition 3—A slight turbulence in the reservoir fluid occurring when the brake pedal is released. Turbulence occurs as brake fluid returns to the master cylinder after releasing the brakes.

Condition 4—A trace of brake fluid exists on booster shell below the master cylinder mounting flange. This condition results from the lubricating action of the master cylinder wiping seal.

Under the vehicle inspect the brake lines for damage and proper routing. Look at the hoses connecting the brake lines to the calipers and to the brake lines attached to the rear suspension control arms. The hoses must not show any signs of damage, cracking or softening. The hose fittings must be tight without signs of leakage.

If signs of leakage are not present and yet the master cylinder is low, it is possible that all evidence of fluid leakage may have been washed off by rain or snow because brake fluid is water soluble. Refill the system, bleed the system, and apply the brakes several times. Examine the system to verify the reservoir level is actually dropping. Locate and correct the external leak.

DIAGNOSIS

TROUBLESHOOTING CHART
BRAKE SYSTEM

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
BRAKE WARNING LIGHT IN INSTRUMENT CLUSTER ON	Low fluid level	Fill system. Check for leaks. for leaks.
	Leaking master cylinder Primary piston cup	Overhaul or replace master cylinder.
	Parking brake not fully released	Free up and adjust parking brake. Replace defective parts.
	Parking brake wiring grounded switch grounded	Repair wiring. Replace switch.
	NOTE: The brake indicator light in the auxiliary warning panel will come on if the front disc brake pads are worn and require replacement.	
LOW PEDAL	Rear brake self-adjuster not operating properly	Check self-adjusting mechanism. Repair or replace defective parts.
	Caliper piston or slide pins sticking	Repair or replace caliper or slide pins.
	Loose wheel bearings	Disassemble front spindles, inspect bearings.
PEDAL GOES TO FLOOR	Leak in hydraulic system	Repair leak. Check entire hydraulic system. Refill and bleed.
	Air in system	Bleed brakes. Check for leaks.
	Worn master cylinder piston cups or scored cylinder bore	Overhaul or replace master cylinder.
	Disc brake "knock back" (Pads push caliper piston back into caliper. Caused by excessive rotor lateral runout or loose wheel bearings.)	Check rotor runout, machine or replace rotor. Adjust front wheel bearings.

CH5228-A1

DIAGNOSIS (Continued)

TROUBLESHOOTING CHART
BRAKE SYSTEM (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
SPONGY BRAKE PEDAL	Air in hydraulic system	Bleed hydraulic system. Check for leaks.
	Bent rear shoe platforms	Replace rear shoes.
	Drums or rotors worn or too thin	Replace drums or rotors.
	Drums bell-mouthed or tapered	Replace drums.
	Brake linings not fully seated to drums or rotors	Burnish linings. (Apply brakes 30 to 40 medium pressure stops being careful not to overheat linings.)
HARD BRAKE PEDAL	Incorrect or defective lining material	Replace brake linings.
	Bent, distorted brake lining	Replace linings.
	Brake linings contaminated with grease or brake fluid	Replace linings. Repair cause of contamination.
	Leaking brake booster or vacuum hose (usually accompanied by a rough engine idle)	Replace power booster or repair vacuum leak.
	Frozen caliper or wheel cylinders	Repair or replace.
	Rear brake shoes binding on backing plate slide pads	Sand slide pads and apply a small amount of high temperature lithium lube. Replace backing plate if heavily grooved.
	Hot spotted drums or rotors	Replace drums or rotors. Check for binding brake or parking brake which caused excessive heat.
	Power booster binding	Replace booster.
	Bent or clogged fluid lines, hoses or fittings	Replace restricted components.
	Contaminated brake fluid (causing rubber compounds to swell and bind in their bores)	Replace all rubber components, flush and refill system.

CH5228-A2

DIAGNOSIS (Continued)

TROUBLESHOOTING CHART
BRAKE SYSTEM (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
BRAKES GRAB	Linings contaminated by grease or brake fluid	Replace linings. Repair cause of contamination.
	Brake shoes bent, distorted, cracked or loose on platform	Replace brake linings.
	Loose backing plate	Tighten rear bearing hub attaching bolts. Replace if worn or bent.
	Loose caliper slide pins or anchor bolts	Tighten slide pins or bolts. Check for hole elongation.
	Hot spotted drums or rotors	Replace drums or rotors.
	Binding wheel cylinders or caliper pistons	Overhaul or replace wheel cylinders or calipers.
	Frozen or incorrectly adjusted parking brake components	Repair or replace frozen components.
BRAKES DRAG	Frozen or incorrectly adjusted parking brake components	Repair or replace frozen components.
	Broken or weak rear brake return springs	Replace springs.
	Caliper or wheel cylinder pistons frozen	Overhaul or replace calipers or wheel cylinders.
	Brake pedal binding at pivot points	Repair or replace brake pedal bushings or pedal assembly.
	Stop switch light incorrectly adjusted, not letting pedal return	Adjust stop light switch.
	Power booster binding	Replace power booster.
	Master cylinder compensating ports plugged	Unplug compensating ports using compressed air. Replace if obstruction cannot be removed.

CH5228-A3

DIAGNOSIS (Continued)

TROUBLESHOOTING CHART
BRAKE SYSTEM (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
BRAKE PEDAL PULSATES	Brake drums out-of-round	Replace drums.
	Disc rotors have excessive lateral runout	Machine rotors, replace if necessary.
	Loose wheel bearings	Adjust wheel bearings.
	Bent front/rear spindles	Replace spindle.
	Bent or distorted hub mounting flange	Replace hub.
BRAKE NOISE	Worn brake linings	Replace linings.
	Bent, cracked brake lining platforms	Replace linings.
	Foreign objects in linings	Replace linings, check drums for scoring.
	Cracked or heat checked drums or rotors	Replace drums or rotors.
	Broken or loose rear brake hold-down or return springs	Replace hold-down or return springs.
	Dry or rough backing plate slide pads	Sand and lubricate slide pads.
	Loose or missing disc brake anti-rattle springs	Repair or replace anti-rattle springs.
	Loose caliper mounting bolts	Tighten mounting bolts, check for hole elongation.

CH5228-A4

DIAGNOSIS (Continued)

TROUBLESHOOTING CHART
BRAKE SYSTEM (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
BRAKE SHUDDER	Brake linings contaminated with grease, brake fluid or foreign objects	Replace linings. Repair cause of contamination.
	Rusted brake drum or disc rotor	Machine or replace drums or rotors. Check linings.
	Excessive disc rotor lateral runout	Machine or replace rotor.
	Rear drum out-of-round, bell-mouthed or spiral threaded	Replace rear drums.
	Loose or broken rear brake hold-down or return springs	Replace loose or broken springs.
	Loose or broken caliper mounting bolts	Tighten or replace mounting bolts.
	Loose wheel bearings	Adjust wheel bearings.
	Loose, worn front suspension or steering components	Repair or replace suspension or steering components.
BRAKES PULL	Brake pads contaminated with grease, brake fluid	Replace pads. Repair cause of contamination.
	Wheel bearing incorrectly adjusted or worn	Adjust or replace wheel bearings.
	Incorrect tire pressure	Inflate tires to specified pressure.
	Caliper piston frozen or sticking	Repair or replace caliper.
	Loose or broken caliper mounting bolts	Tighten or replace bolts.
	Bent or restricted brake line or hose	Replace restricted lines or hoses.
	Loose or worn suspension or steering components	Repair or replace faulty suspension or steering components.
	Incorrect front end alignment (Incorrect caster would be the most likely cause)	Check front end. If necessary, refer to Section 14-01.

CH5228-A5

DIAGNOSIS (Continued)

Hydraulic System Diagnosis

Internal and external leaks are the two problems that can affect a brake hydraulic system. The hydraulic brake system does not cause the vehicle to vibrate or pull, the brakes to grab or squeal, or the brake pedal to pulse. In most cases the hydraulic system will not even make the brakes drag. The sources of these problems are found elsewhere in the brake system, but it is always a good policy to first check the entire hydraulic system for leaks before continuing to diagnose any other brake problems. If necessary, refer to the visual inspection in this Section.

Master Cylinder

Usually, the first and strongest indicator of anything wrong in the brake system is a feeling through the brake pedal. The Troubleshooting Chart—Master Cylinder uses pedal feel as evidence of a brake problem. It also employs two other problem indicators, such as the illumination of the brake warning lamp and the brake fluid level in the master cylinder's reservoir.

Note that the Master Cylinder Diagnosis Chart refers to the use of diagnostic techniques. These techniques (Numbers 1 through 6) follow the diagnostic chart.

NOTE: Prior to performing any diagnosis, make certain that the brake system warning lamp is functional.

DIAGNOSTIC PROCEDURES

TROUBLESHOOTING CHART—MASTER CYLINDER DIAGNOSIS

MASTER CYLINDER DIAGNOSIS

Brake Pedal Feel Conditions	Diagnostic Action
Condition 1 — Pedal goes down fast and brake warning lamp comes on.	Pump brake pedal rapidly: If the brake pedal height builds up and holds, check for the presence of air. (Use Diagnostic Technique No. 1.) If the brake pedal height builds up and then sinks down, check for an external leak. (Use Diagnostic Technique No. 4) or a master cylinder by-pass. (Use Diagnostic Technique No. 2.) If the brake pedal height fails to build up, check the fluid level in the master cylinder reservoir: If a reservoir is empty, add fluid; bleed the system; and check for external leak. (Use Diagnostic Techniques No. 3 and No. 4.) If the reservoir is full, check for a gross master cylinder by-pass. (Use Diagnostic Technique No. 2.)
Condition 2 — Pedal eases down slowly and brake warning lamp comes on.	This condition could be caused by an external leak in the brake system or an internal by-pass in the master cylinder. Apply the brakes several times while observing the fluid level in the reservoir. If the net fluid level in the reservoir eases down with each stroke cycle, check for an external leak. (Use Diagnostic Technique No. 4.) **If the fluid level in the reservoir rises while the pedal eases down and drops when the pedal is released, but the net fluid level remains unchanged, then service the master cylinder for a fluid by-pass condition.** CH2935-E1

DIAGNOSTIC PROCEDURES (Continued)

MASTER CYLINDER DIAGNOSIS (Continued)

Condition 3 — Pedal is low and brake warning lamp does not come on.	This condition may be caused by: air in the hydraulic system, or no fluid in the reservoir. If the reservoir is empty, add fluid, bleed, and check the system for external leaks. (See Diagnostic Technique Nos. 3 and 4.) If the reservoir is full, check for the presence of air in the hydraulic system. (Use Diagnostic Technique No. 1.) If this condition happens occasionally, check the front wheel bearings for looseness. (Loose front wheel bearings allow the disc rotor to knock the caliper piston back, creating excessive lining clearance.)
Condition 4 — Pedal feels spongy.	This may be normal as newer brake systems are not designed to produce as hard a pedal as in the past. To verify this, compare the pedal feel with another like vehicle. Check for the presence of air in the hydraulic system. (Use Diagnostic Technique No. 1).
Condition 5 — Pedal erratic — no brake warning lamp.	This may be caused by incomplete brake release, loose wheel bearings, incorrect parking brake adjustment or blocked compensator holes in the master cylinder. To verify, check wheel rotation and bearing free play, parking brake tension and refer to Diagnostic Technique No. 6 for master cylinder compensator hole check.

CH2935-E2

NOTE: Always check the fluid level in the master cylinder before performing the test procedures. If the fluid level is not at the correct level indicated on the master cylinder reservoir, add brake fluid, Ford Part No. C6AZ-19542-A, DOT-3 or DOT-4 equivalent.

Air Trapped in Brake System

1. Check the master cylinder fluid level.
2. Place the cap loosely on the master cylinder.
3. With one technician acting as an observer at the master cylinder, and another technician applying the brakes, pump the brakes **rapidly** 20 times.
4. On the final application, hold the pedal in the applied position.
5. Remove the cap, and observe the fluid in the reservoir. Quickly release the brake pedal. A geyser will spout in the reservoir if the system has air in it.

NOTE: Pumping the brake pedal compresses trapped air. When the brake pedal is released, the compressed air expands, forcing brake fluid back into the master cylinder with sufficient force to form a geyser.

6. Bleed the system in which the geyser occurs. If necessary, refer to Section 12-80.

Checking a Master Cylinder Bypass Condition (No. 2)

1. Check the master cylinder fluid level.
2. With the reservoir cap removed, observe the fluid level, when the brake pedal is slowly depressed for one stroke and then quickly released.

   If the fluid level in the reservoir rises while the pedal goes down and drops when the pedal is released, but the net (overall) fluid level in the reservoir remains unchanged, the master cylinder is bypassing. Service such a master cylinder. If necessary, refer to Section 12-80.

Checking the Cause of an Empty Reservoir

Without an External Pressure Leak (No. 3)

An empty reservoir condition may be caused by two types of non-pressure external leaks.

Type 1: An external leak may occur at the master cylinder reservoir cap because of improper positioning of the cap.

Type 2: An external leak may occur at the mounting end of the master cylinder because of a bore end seal leak. Service the master cylinder. If necessary, refer to Section 12-80.

DIAGNOSTIC PROCEDURES (Continued)

Checking for External Fluid Leaks in the Brake System (No. 4)

Refer to Hydraulic System Visual Inspection in this Section.

Checking for Brake Pedal Reserve (No. 5)

1. With the engine off, pump the brake pedal several times to deplete the vacuum reserve in the power booster.
2. Install Brake Pedal Effort Gauge 021-00001.
3. Press on the brake pedal with a force of about 220N (50 lbs) and measure the pedal height. If necessary, refer to the Brake Pedal Travel Measurement procedure in this Section.

   If pedal travel is greater than 70mm (about 2 3/4 inches), bleed the brakes and recheck pedal travel.

   NOTE: The maximum permitted travel is 70mm. However, anything above 60mm (about 2 3/8 inches) suggests air in the system. Bleed the brakes and recheck pedal travel.

   If the brake pedal is still believed to be bottoming out, pedal reserve can be confirmed as follows:

   a. Press the brake pedal with moderate to severe pressure and note the amount of brake pedal travel.

   b. Open a bleeder screw at one front caliper and one rear wheel cylinder. Press the brake pedal and note the amount of pedal travel.

      Pedal travel should increase as the master cylinder forces fluid through the bleeder screws and bottoms out. If pedal travel does not increase, the master cylinder was bottoming out in previous steps.

   c. Close the bleeder screws and refer to the Troubleshooting Charts for causes of excessive pedal travel.

Checking the Master Cylinder for Open Compensator Port (No. 6)

If it is believed that the master cylinder is failing to return to the fully released position, proceed as follows:

1. Raise the front of the vehicle and support it on safety stands.
2. With the brakes off, attempt to rotate both front wheels by hand. To minimize brake pad drag, rock the wheel on the spindle as it is rotated.

   If an excessive amount of brake drag is apparent at both wheels, the master cylinder may not be returning to the released position. Proceed to the next step.

   If an excessive amount of brake drag is apparent at only one wheel, it indicates a possible seized caliper piston.
3. Check the brake light switch adjustment to make sure the switch is not holding the brake pedal in the partially applied position. If the brake light switch is properly adjusted, proceed to the next step.
4. Loosen the nuts attaching the master cylinder to the power booster and pull the master cylinder away from the booster. If the brake drag disappears, the power booster is binding and should be replaced.

   If the brake drag continues, the master cylinder is not operating properly and should be replaced.

Brake Booster Functional Test

Inspect all vacuum hoses and connections. All unused vacuum connectors should be capped. Hoses and their connections should be properly secured and in good condition with no holes or no collapsed areas. Inspect the check valve on the power booster for damage.

Check the booster operation as follows:

1. Check the hydraulic brake system for leaks or insufficient fluid.
2. With the transmission in Park or Neutral, stop the engine, and apply the parking brake. Depress the service brake pedal several times to exhaust all vacuum in the system.
3. With the engine turned off and all vacuum in the system exhausted, depress the service brake pedal and hold it in the applied position. Start the engine. If the vacuum system is operating, the pedal will tend to move downward under constant foot pressure. If no motion is felt, the vacuum booster system is not functioning.
4. Remove the vacuum hose from the brake booster check valve. Manifold vacuum should be available at the check valve end of the hose with the engine at idle speed and the transmission in Neutral. Be sure that all unused vacuum outlets are properly capped, hose connectors are properly secured, and vacuum hoses are in good condition.

   When it is established that manifold vacuum is available to the booster, connect the vacuum hose to the booster and repeat Step 3. If no downward movement of the brake pedal is felt, replace the brake booster.

DIAGNOSTIC PROCEDURES (Continued)

5. Operate the engine a minimum of 10 seconds at fast idle. Stop the engine, and let the vehicle stand for 10 minutes; then, depress the brake pedal with approximately 20 pounds of force. The pedal feel (brake application) should be in the same as that noted with the engine operating. If the pedal feels hard (no power assist), replace the check valve, then repeat the test. If pedal still feels hard, replace the brake booster.

   If the brake pedal movement feels spongy, bleed the hydraulic system to remove air from the system. If necessary, refer to Section 12-80.

   Refer to the Brake Booster Troubleshooting Chart, to facilitate vacuum booster diagnosis.

Troubleshooting Chart Brake Booster

VACUUM BRAKE BOOSTER DIAGNOSIS
EXCESSIVE BRAKE PEDAL EFFORT OR VACUUM LEAKS

TEST STEP		RESULT ▶	ACTION TO TAKE
B0	VERIFY CONDITION		
• With engine OFF, depress and release brake pedal five times to deplete all vacuum from booster. Depress pedal, hold with light pressure. Start engine.		Pedal falls slightly, then holds ▶	GO to **B1**.
		(OK) ▶	GO to **B3**.
B1	VACUUM BOOSTER LEAK TEST		
• Run engine to medium speed, release accelerator and turn engine off. Wait 90 seconds and apply brakes. Two or more applications should be power assisted.		(OK) ▶	Vehicle OK.
		(OK) ▶	GO to **B2**.
B2	POWER SECTION CHECK VALVE TEST		
• Disconnect vacuum hose for booster check valve at manifold. Blow into hose attached to check valve.		Air passes through check valve ▶	INSTALL new check valve and REPEAT Step **B1**.
		(OK) ▶	REPLACE booster. REPEAT Step **B0**.

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DIAGNOSTIC PROCEDURES (Continued)

VACUUM BRAKE BOOSTER DIAGNOSIS
EXCESSIVE BRAKE PEDAL EFFORT OR VACUUM LEAKS (Continued)

B3	POWER SECTION TEST		
	• Disconnect vacuum hose from booster check vacuum check valve. Run engine at idle. Check vacuum supply with a vacuum gauge.	Above 40.5 kPa (12 inches Hg) and booster does not operate ▶	REPLACE booster. REPEAT Step **B0**.
		Below 40.5 kPa (12 inches Hg) ▶	REPLACE or SERVICE vacuum hose and vacuum fittings. Also TUNE or SERVICE engine as required. REPEAT Step **B0**.

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Slow or Incomplete Brake Pedal Return

VACUUM BRAKE BOOSTER DIAGNOSIS
SLOW OR INCOMPLETE BRAKE PEDAL RETURN

TEST STEP		RESULT ▶	ACTION TO TAKE
D0	VERIFY CONDITION		
	• Run engine at fast idle. Pull brake pedal rearward with approximately 10 pounds force. Release the pedal and measure the distance to the toe board. Make a heavy brake application. Release the brake pedal and measure the pedal to toe board distance. The pedal should return to its original position.	(OK) ▶	Vehicle OK.
		(OK) ▶	GO to **D1**.
D1	BRAKE PEDAL BINDING		
	• Check pedal to be sure it is operating freely.	(OK) ▶	GO to **D2**.
		(OK) ▶	CORRECT any sticking or binding. REPEAT Step **D0**.
D2	PUSHROD ADJUSTMENT		
	• Remove master cylinder reservoir cover and depress brake pedal rapidly. Fluid surface should have some movement or spout in forward reservoir.	(OK) ▶	Vehicle OK.
		(OK) ▶	ADJUST pushrod. REPEAT Step **D0**.

CH3131-A

DIAGNOSTIC PROCEDURES (Continued)

Vacuum Brake Booster Noise

VACUUM BRAKE BOOSTER DIAGNOSIS
VACUUM BRAKE BOOSTER NOISE

TEST STEP		RESULT	ACTION TO TAKE
C0	VERIFY CONDITION		
• Run engine at fast idle for 10 seconds or longer. Depress brake pedal and listen for noise. Compare results with known good system.		(OK) ▶	Vehicle OK.
		Noise ▶	REPLACE booster.

CH3130-A

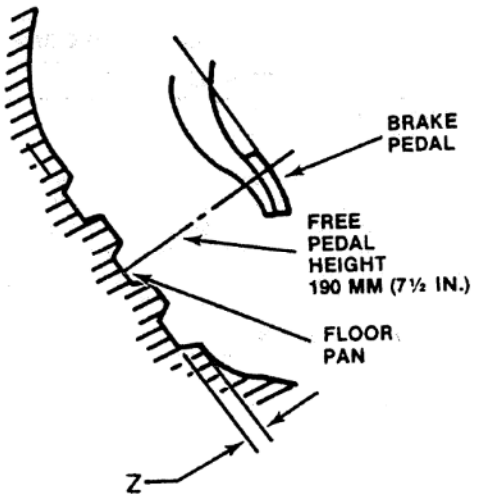
Brake Pedal Height

A low brake pedal complaint can occur because the owner's previous vehicle had different brake pedal "feel." To determine if pedal height and travel are within the vehicle design standards, use the following procedures.

With the engine running for full power brake operation and the parking brake fully released, measure the brake pedal free height, and check the brake pedal travel with the use of the Brake Pedal Effort Gauge, Rotunda Model 021-00001, or equivalent, as follows:

1. Insert a slender, sharp-pointed prod through the carpet and sound deadener to the dash panel metal. Measure the distance to the center top of the brake pedal pad.
2. If the position of the pedal is not 190 mm (7 1/2 in.), check the brake pedal for missing, worn, or damaged bushings, or loose attaching bolts, and replace them, if required. Also check that the floor pan has not been distorted or the brake pedal bent.
3. If the pedal free height is still out of specification, check the brake pedal, booster, or master cylinder to be sure the correct parts are installed. Replace the worn or damaged parts as necessary.

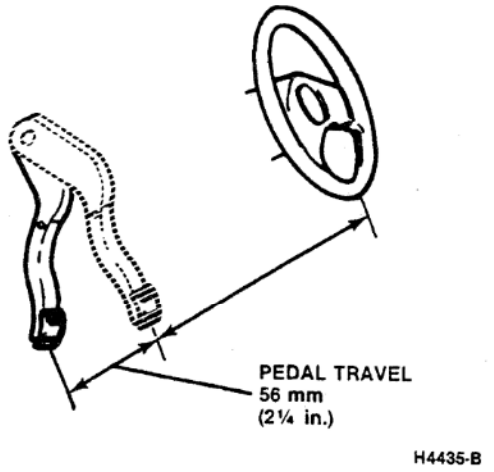
Brake Pedal Free Height Measurements



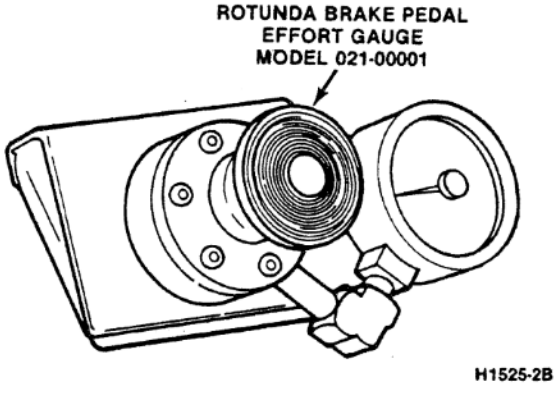
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DIAGNOSTIC PROCEDURES (Continued)

Brake Pedal Travel Measurement



1. Make sure the parking brake is released.
2. Make sure the master cylinder is filled to the correct level.
3. Install the brake pedal effort gauge on the brake pedal pad.
4. Make sure the rear brakes are fully adjusted by applying a 500N (110 lbs) load to the pedal.



5. Hook a steel measuring tape to the brake pedal. Measure and record the distance from the brake pedal free height position to the reference point, at the six o'clock position on the steering wheel rim.
6. With the steel tape still hooked to the brake pedal, depress the brake pedal by pressing downward on the brake pedal effort gauge. Apply a 25-pound load to the center of the pedal. Maintain the pedal load and measure the distance from the brake pedal to the fixed reference point on the steering wheel rim parallel to the centerline of the steering column.
7. The difference between the brake pedal free height and the depressed pedal measurement under a 25-pound load should be 56mm (2 7/32 in.) plus or minus 10mm (1/32 in.).
8. If the pedal travel is more than specification, make several reverse stops and forward stops. Move the vehicle in reverse and forward for approximately ten feet; then, apply the brakes holding the brake pedal down until the vehicle is completely stopped. This will actuate the brake self-adjusters. If these stops do not bring the brake pedal travel within specification, make several additional forward and reverse stops as outlined above.
9. If the second series of stops does not bring brake pedal travel within specification, then, remove brake drums, and check the brake adjusters to make sure they are functioning. Check brake linings for wear or damage. Service or replace all worn or damaged parts and non-functioning adjusters. Adjust the brake lining outside diameter to the approximate inside diameter of the brake drum with brake adjustment gauge, Tool D81L-1103-A, or equivalent.
10. If all the drum brake adjusters, brake drums, and brake shoe linings are functional and the brake travel is not within specifications, check the pedal assembly for missing or worn bushings or loose attachments.
11. If the above steps do not bring the brake travel within specification, bleed the brake system.

Brake Shudder

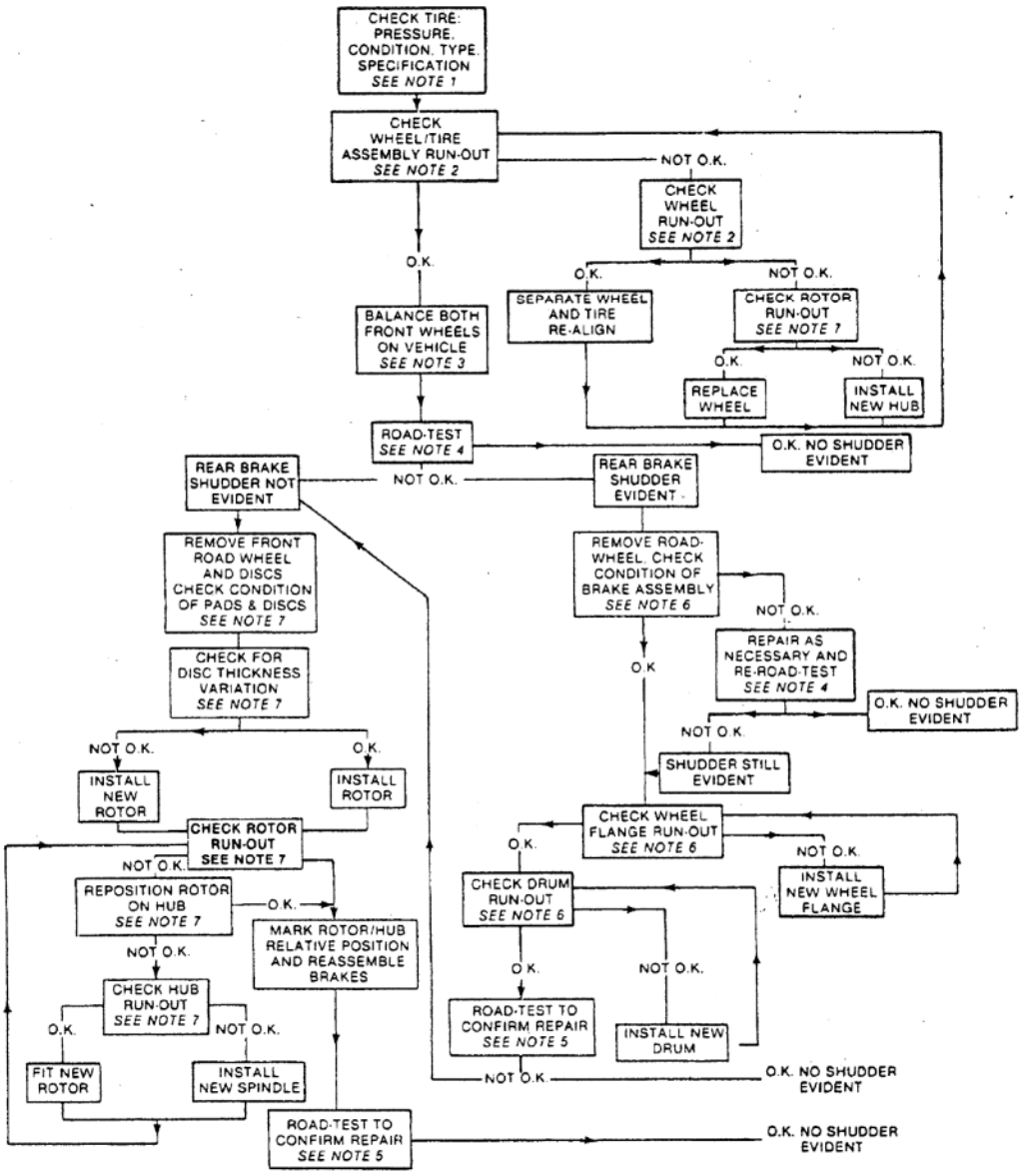
When investigating customer complaints of brake shudder, it is important that the condition is accurately diagnosed before carrying out corrective actions. Failure to do this may result in unnecessary work and replacement of serviceable components without correcting the customer complaint.

Therefore, should a customer express concern about brake shudder the sequence and procedures detailed in this procedure must be followed exactly to ensure that the shudder condition is eliminated.

This procedure is divided into two sections, a diagnostic procedure chart shown below, and explanatory notes for the chart.

DIAGNOSTIC PROCEDURES (Continued)

Brake Shudder Diagnostic Chart



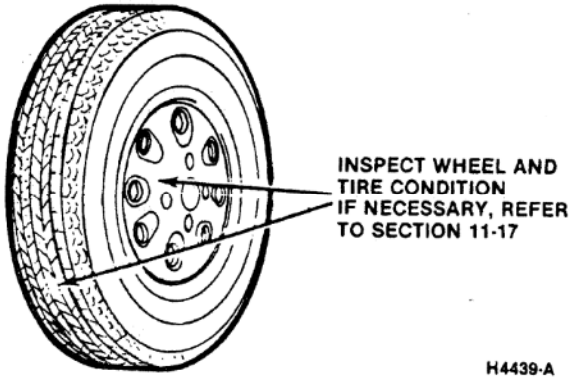
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DIAGNOSTIC PROCEDURES (Continued)

Brake Shudder

Explanatory Notes

NOTE 1: TIRE CONDITION/SPECIFICATION PRESSURE



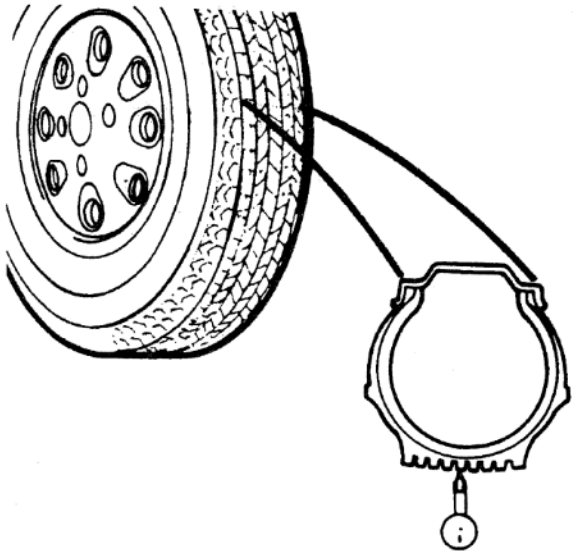
H4439-A

Visually examine front and rear tires and wheel assemblies for damage such as uneven wear, tread wash-outs, or sidewall damage. Make sure the tires are of the same size, type and where possible same manufacture. Any tire or wheel that is damaged should be replaced. If necessary, refer to Section 11-01.

Wheels and tires must be cleared of any foreign matter and tire pressures adjusted to the correct specification as detailed in Section 11-17.

If tires exhibit biased wear or feathering, the cause must be corrected. Check steering and suspension components for damage/wear and, if necessary, check and adjust steering geometry. If necessary, refer to Section 14-01.

NOTE 2: FRONT WHEEL, TIRE AND HUB RADIAL RUNOUT



H4449-A

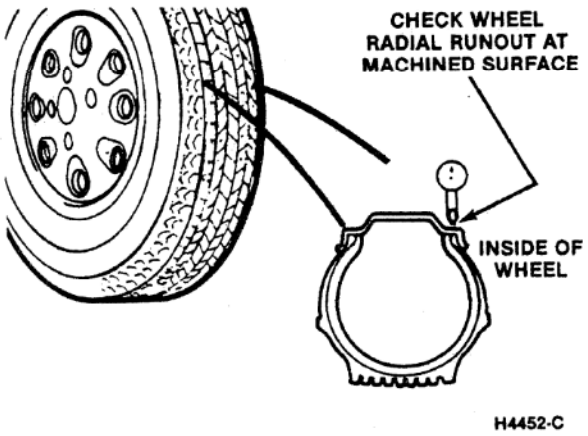
Wheel and tire assembly runout check:

Jack the front of the vehicle off the ground, and place a support underneath the control arm to prevent suspension movement. Using a dial indicator, measure the radial runout of the tire at the center and outside ribs of the tread face. Mark low and high positions of radial runout. Radial runout must not exceed 1.6mm (0.063 in.).

DIAGNOSTIC PROCEDURES (Continued)

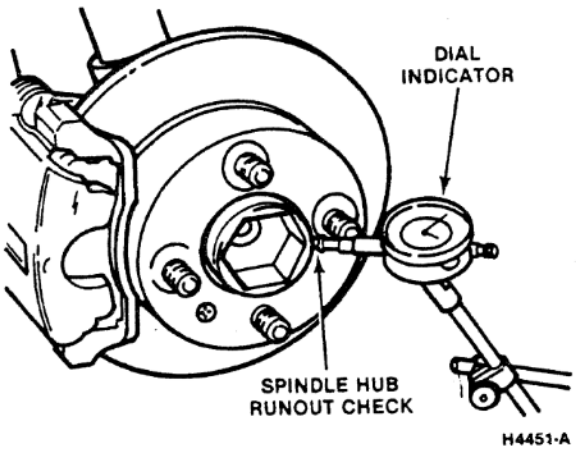
Wheel runout check:

Readjust the gauge mounting brackets and using a dial gauge, measure the wheel rim runout and record high and low positions. The wheel rim runout must not exceed 1.0mm (0.039 in.). Measure wheel radial runout at the wheel rim along the inside edge of the flange. If indicator reading is in excess of 1.0mm (0.039 in.), the hub radial runout must be checked as detailed below.



NOTE: If the reading for wheel runout is within specification and tire runout is outside specification, the tire must be rotated on the wheel rim until the tire runout is within specification. Recheck tire radial runout until an OK specification is obtained.

Hub runout check:



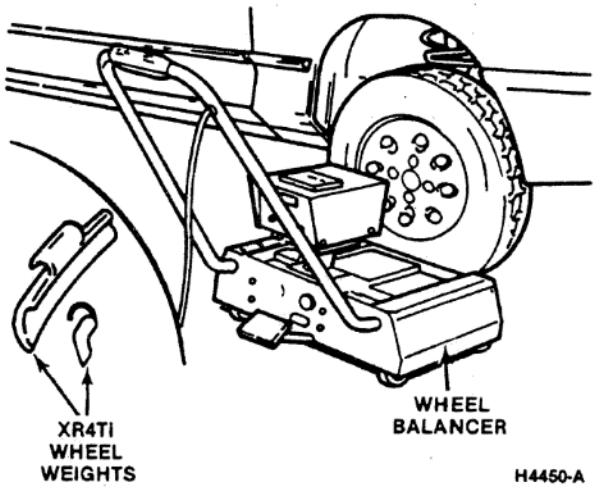
Remove the wheel, reposition the dial indicator and measure the spindle hub radial runout. The total indicator reading of the hub spigot runout must not exceed 0.08mm (0.003 in.).

NOTE: If the spindle runout is within specification, this indicates the wheel itself is outside specification and must be replaced.

If the spindle hub is outside specification, the hub should be replaced. If necessary, refer to Section 11-16. The front wheel/tire and hub assembly radial runout should be rechecked until an OK condition is reached.

If a new hub is installed, index the hub to the rotor using the procedure outlined in NOTE 7.

NOTE 3: BALANCE FRONT ROAD WHEELS



Check front wheel and tire assembly balance. If necessary, refer to Section 11-01.

Front road wheels must be balanced on the vehicle, both statically and dynamically.

DIAGNOSTIC PROCEDURES (Continued)

NOTE 4: ROAD TEST ONE

Customer complaints of brake shudder can often be influenced by factors independent of the braking system. Therefore, it is important that you adhere as closely as possible to the procedure detailed below in order that the causes of the customer complaint can be accurately identified.

1. Drive the vehicle up to speed.

NOTE: Brake shudder has been found to be most apparent when braking from speeds around 112 to 120 kph (70 to 75 mph). Therefore, subject to local road conditions/speed limits the vehicle should be driven as near to the speed as possible during the road test.

2. When safe to do so, apply the footbrake and brake lightly to rest, noting the speeds at which shudder is apparent. (Identified by steering wheel vibration and brake pedal pulsation.)
3. Repeat Steps 1 and 2 twice more, to confirm the critical speed ranges.

NOTE: Allow 1.6 km (1 mi) between each application to allow the brakes to cool.

4. Return to the critical shudder speed, but, instead of applying the foot brake, apply the handbrake lightly with the release button depressed. Check for vibration through the handbrake and/or steering wheel.
   - If vibration is apparent when carrying out the handbrake test, this indicates rear brake shudder is present. This must be investigated and eliminated before investigating whether front brake shudder is also present.
   - If vibration is only apparent when the footbrake is applied, it can be assumed the rear brakes are functioning satisfactorily. In these circumstances continue with the front brake diagnostic sequence.

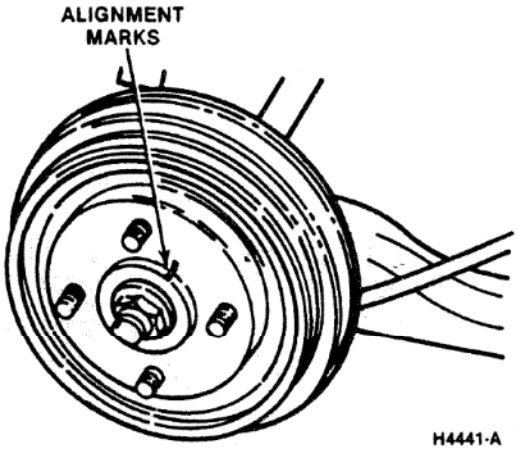
NOTE 5: ROAD TEST TWO

Road-test the vehicle as described in Steps 1, 2, and 3 only of Road Test One, continue with the front brake diagnostic sequence **only** if footbrake shudder is still apparent.

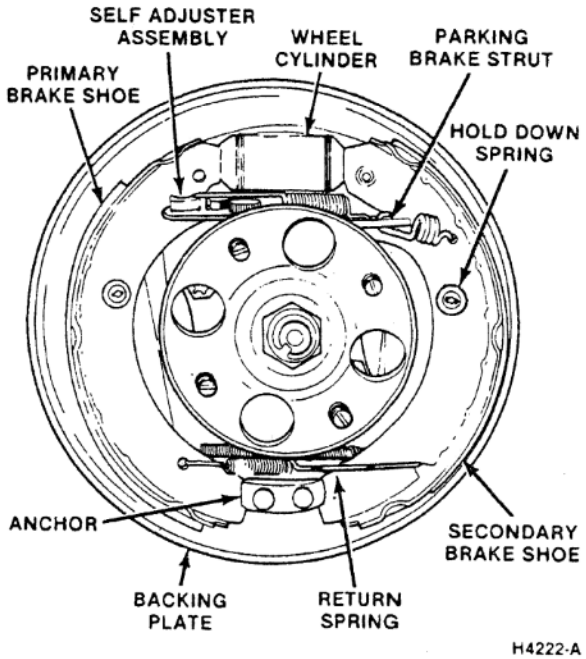
NOTE 6: REAR BRAKE SHUDDER

If the road test has established a rear brake judder condition (Road Test One, Step 4) the following procedure must be used to isolate the cause.

1. Mark the wheel in relation to the hub with a paint spot to ensure that the components are repositioned in the same position on reassembly.
2. Remove both the rear wheels, mark the drums and hubs in relation to each other, and remove both drums.



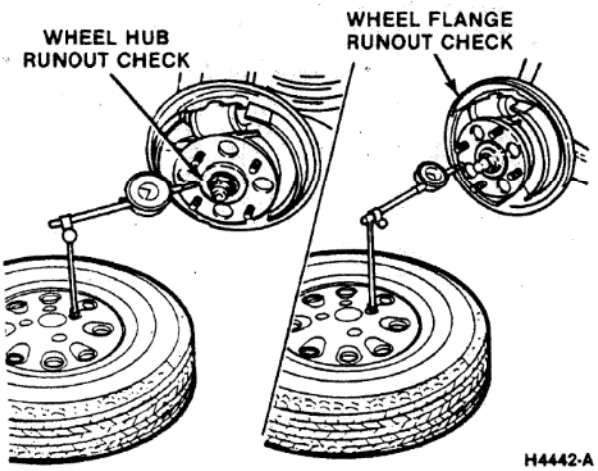
3. Check the condition of brake components for serviceability (e.g. lining condition, loose backing plate, contaminated linings and brake drum condition, etc.). Make sure the shoe to backing plate contact points and shoe ends are smeared with grease. If necessary, refer to Section 12-02.



NOTE: If any components require replacing or repair, this should be carried out and the vehicle road-tested as detailed in NOTE 4, Step 4 before continuing with the brake shudder procedure.

DIAGNOSTIC PROCEDURES (Continued)

4. If no corrective action is necessary, measure the wheel flange runout using a dial indicator. Position the indicator so that the stylus contacts the flange just outside the wheel studs.



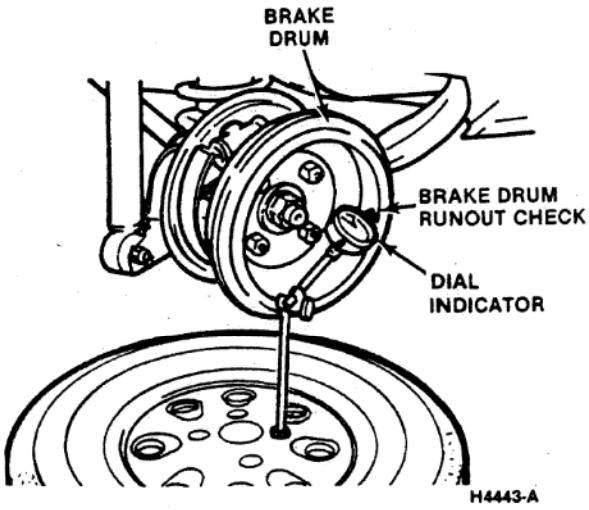
5. Reposition the dial indicator mounting brackets, and measure the wheel flange hub runout.

NOTE: If either reading in Steps 4 and 5 is greater than 0.08mm (0.003 in.), a new wheel flange must be installed and the hub rechecked for runout.

6. Install washers of equal thickness to each of the wheel studs, reverse the brake drum and install on the wheel flange as shown in Figure 7. Install and tighten the wheel nuts.

7. Mount the dial indicator and check the runout of the hub mounting face. This must be checked first to ensure that the brake drum is correctly located and seated onto hub and studs.

8. Reposition dial gauge and check drum runout at the center of the braking surface. This must not exceed 0.13mm (0.005 in.) total indicator reading and should not exceed 0.03mm (0.001 inch) within 30 degrees of its circumference.



NOTE: If either reading is outside specification, install a new drum and make a second runout check.

9. If necessary, assemble the brakes and install the drum. Mark the relative position of the hub and drum using white paint or pin punch. Install the road wheel and tighten the wheel nuts to 70 to 100 N·m (50 to 72 lb-ft).

10. Road-test the vehicle (see Road Test Two) to confirm the repair. If shudder is still evident, proceed to the front brake shudder box on the chart.

NOTE 7: FRONT BRAKE SHUDDER

If the road test has established a front brake shudder condition, the following procedure should be used to isolate the cause.

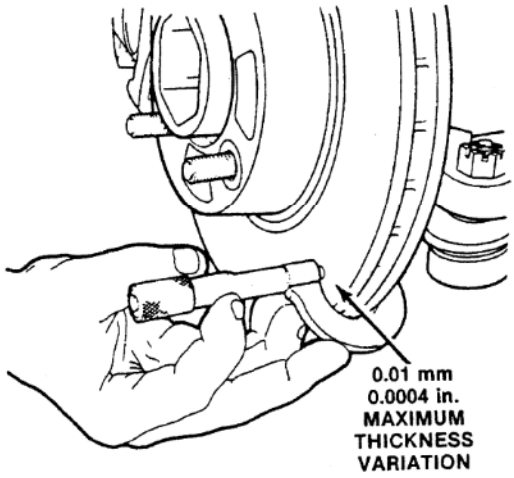
1. Remove the wheel nuts. Before removing the wheel, mark the wheel and one of the wheel studs so that the wheel can be installed in its original position.

2. Examine the condition of the rotor and pad assemblies.

   If there is visible evidence of lining deposits or light corrosion on the rotor this should be removed using emery paper and a flat block.

DIAGNOSTIC PROCEDURES (Continued)

Check the parallelism (thickness variation) of the rotor using a suitable micrometer. Measure the rotor at eight positions 45 degrees apart about 15mm (1/2 in.) in from the outside diameter.



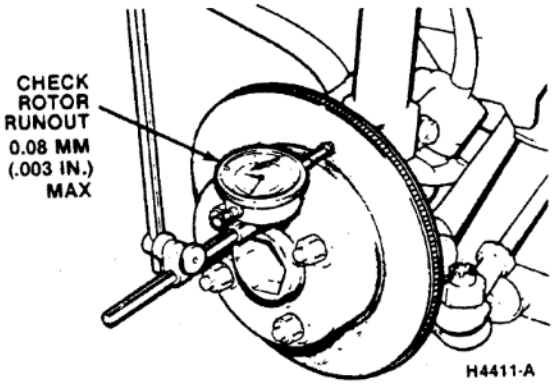
H4444-A

NOTE: It is important to always check at a constant radius.

If any of these readings vary by 0.01mm (0.0004 in.) or more, the rotor should be reconditioned or new rotors should be installed. If necessary, refer to Section 12-20.

NOTE: Wheel nuts must be used and reversed to prevent damage to wheel nut tapered seat.

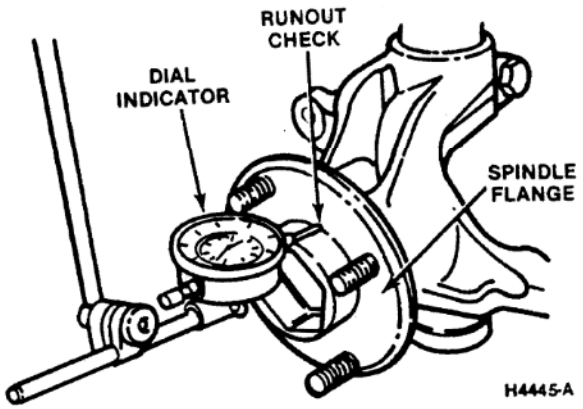
4. Using a suitable dial indicator and holing fixture, measure the rotor runout. Measure the runout about 10mm (7/16 in.) in from the outside diameter.



H4411-A

5. Rotate the hub and rotor assembly. Record indicator reading. If runout is greater than 0.08mm (0.003 in.) total indicator reading, the rotor should be repositioned on the hub at 90 degree increments until the lowest reading is obtained. If runout cannot be reduced to an acceptable level with this method, replace the rotor.

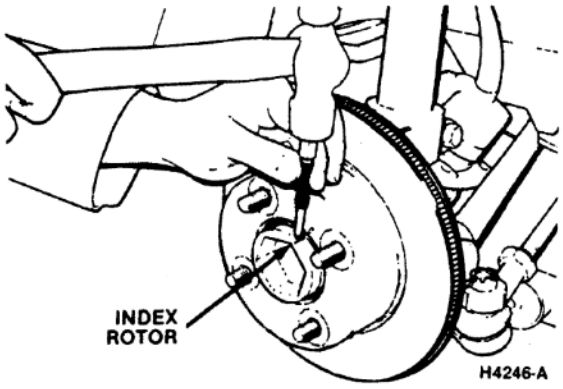
6. If less than 0.08mm (0.003 in.) total indicator reading cannot be obtained, remove the rotor, clean the spindle hub face and check hub face runout just inside the wheel studs. This figure must be within 0.06mm (0.002 in.) total indicator reading.



H4445-A

NOTE: If the hub is outside specification a new spindle must be installed. If the hub runout is within specification, replace the rotor.

7. Once a reading of less than 0.08mm (0.003 in.) is obtained the position of hub and rotor must be marked either with paint or by punch marks.



H4246-A

8. Install the brake caliper, pads and wheel. Tighten the lug nuts to 100 to 144 N·m (75 to 105 lb-ft).

9. Road-test to confirm repair.

DIAGNOSTIC PROCEDURES

BRAKE SHUDDER

Explanatory Notes (Continued)

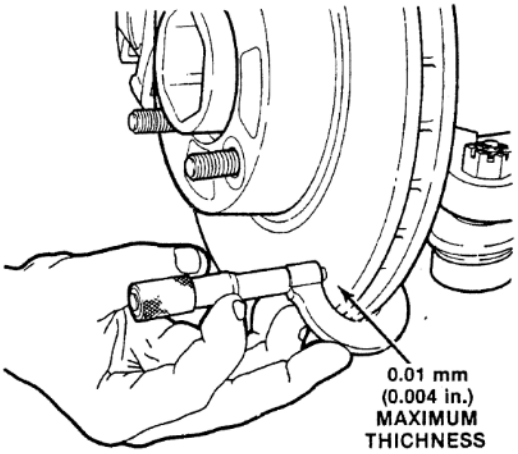
NOTE 7: FRONT BRAKE SHUDDER

If the road test has established a front brake shudder condition, the following procedure should be used to isolate the cause.

1. Remove the wheel nuts. Before removing the wheel, mark the wheel and one of the wheel studs so that the wheel can be installed in its original position.
2. Examine the condition of the rotor and pad assemblies.

   If there is visible evidence of lining deposits or light corrosion on the rotor this should be removed using emery paper and a flat block.

   Check the parallelism (thickness variation) of the rotor using a suitable micrometer. Measure the rotor at eight positions 45 degrees apart about 15 mm (1/2 in.) in from the outside diameter.



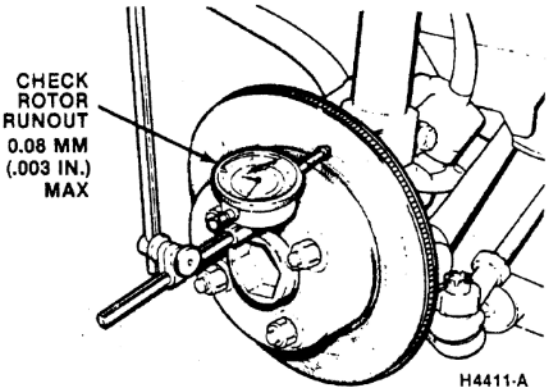
H4444-A

NOTE: It is important to always check at a constant radius.

   If any of these readings vary by 0.015 mm (0.0006 in.) or more, the rotor should be reconditioned or new rotors should be installed. If necessary, refer to Section 12-20.

NOTE: Wheel nuts must be used and reversed to prevent damage to wheel nut tapered seat.

4. Using a suitable dial indicator and holing fixture, measure the rotor runout. Measure the runout about 10 mm (7/16 in.) in from the outside diameter.



H4411-A

5. Rotate the hub and rotor assembly. Record indicator reading. If runout is greater than 0.08 mm (0.003 in.) total indicator reading, the rotor should be repositioned on the hub at 90 degree increments until the lowest reading is obtained. If runout cannot be reduced to an acceptable level with this method, replace the rotor.

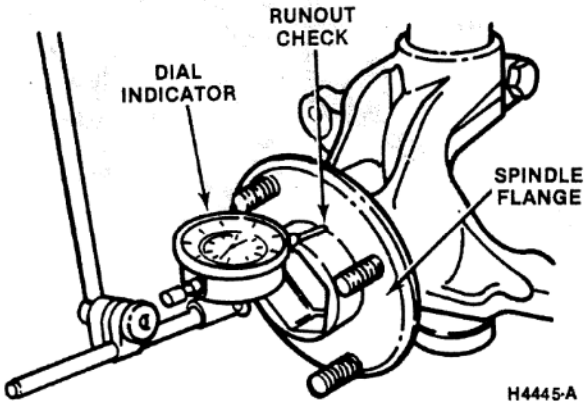
DIAGNOSTIC PROCEDURES

BRAKE SHUDDER

Explanatory Notes (Continued)

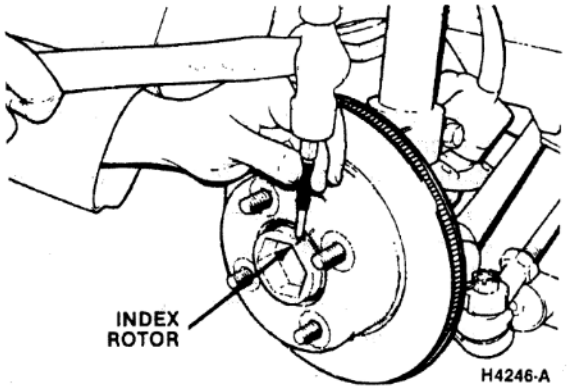
NOTE 7: FRONT BRAKE SHUDDER (Continued)

6. If less than 0.08 mm (0.003 in.) total indicator reading cannot be obtained, remove the rotor, clean the spindle hub face and check hub face runout just inside the wheel studs. This figure must be within 0.06 mm (0.002 in.) total indicator reading.



NOTE: If the hub is outside specification a new spindle must be installed. If the hub runout is within specification, replace the rotor.

7. Once a reading of less than 0.08 mm (0.003 in.) is obtained the position of hub and rotor must be marked either with paint or by punch marks.



8. Install the brake caliper, pads and wheel. Tighten the lug nuts to 100 to 144 N·m (75 to 105 lb-ft).

9. Road-test to confirm repair.

SECTION 12-02 DRUM BRAKES

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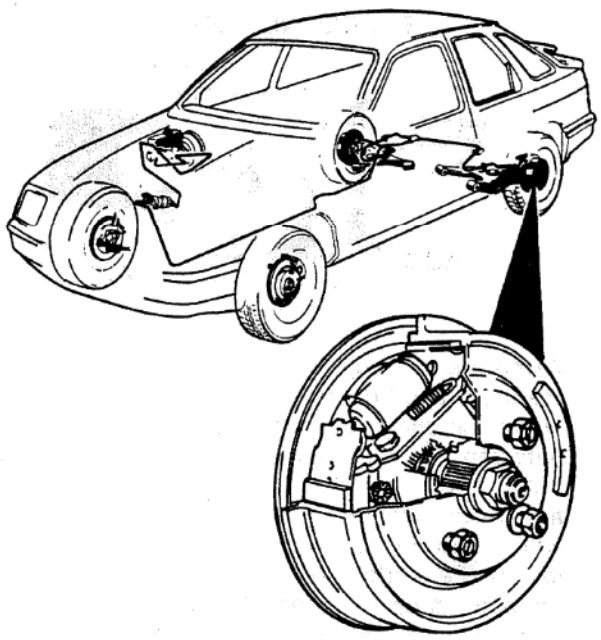
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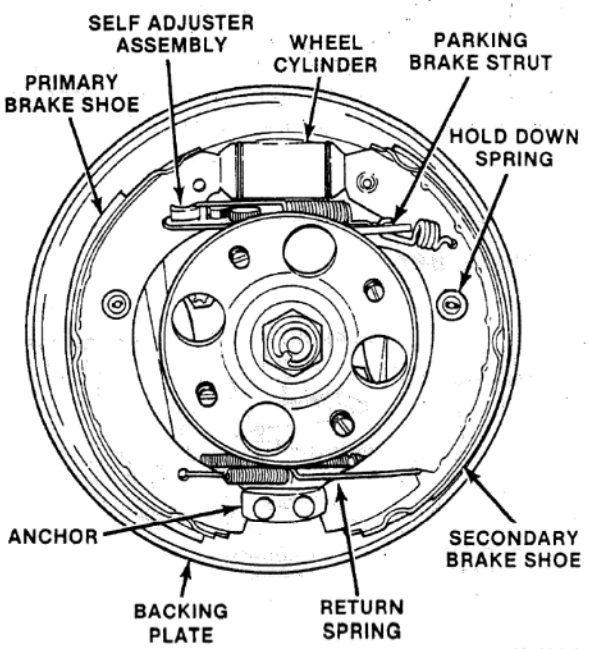


H4221-A

DESCRIPTION

GENERAL

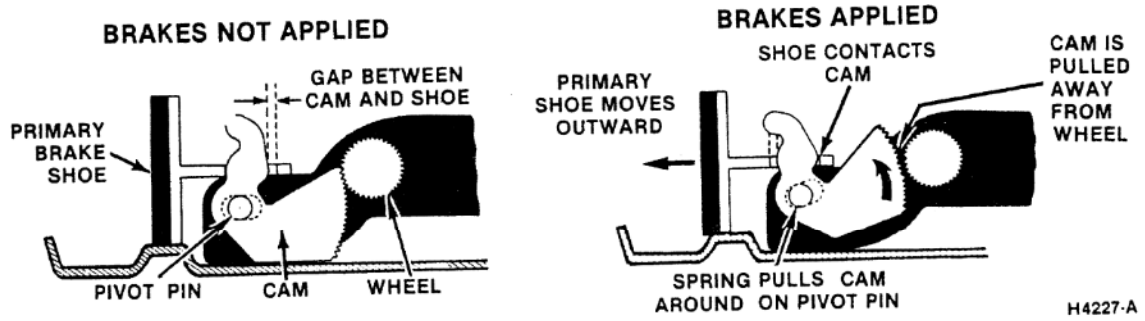
Stopping power is provided by front disc brakes and rear drum brakes. The rear brake is a standard non-servo, self-energizing design. The brakes are applied by a double-acting wheel cylinder mounted at the top of the backing plate. The primary and secondary brake shoes are attached to the backing plate with a hold-down spring, pin and washer. The brake linings are bonded to the brake shoes and contain a carbon compound for extended service life. When installed, the drum is attached to the wheel flange.



H4222-A

DESCRIPTION

SELF-ADJUSTER OPERATION

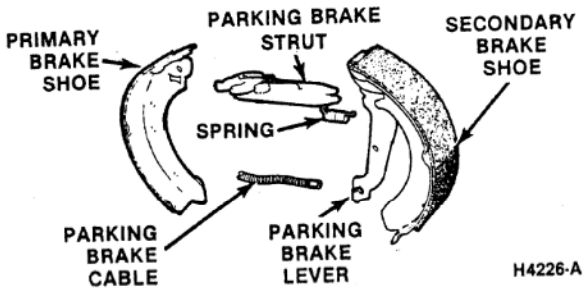


Without a self adjuster, the clearance between the drum and linings would increase as the linings wear and become thinner. And, as the gap between the linings and drum increases, the brake pedal would have to be pushed further and further to move the linings into contact with the drum. The self adjuster eliminates the low brake pedal condition by maintaining a constant drum-to-lining clearance. As the linings wear, the self adjuster automatically repositions the brake shoes outward toward the drums.

The self adjuster is mounted on the parking brake strut and consists of a cam, wheel and spring. The cam fits into a slot in the primary shoe. The cam rotates on a pivot pin when excessive clearance exists between the drum and linings. The stationary wheel is riveted to the strut. The wheel locks against the cam after the cam has rotated to a new position. The cam is held against the wheel by spring tension which prevents slippage between the serrated edges of the components.

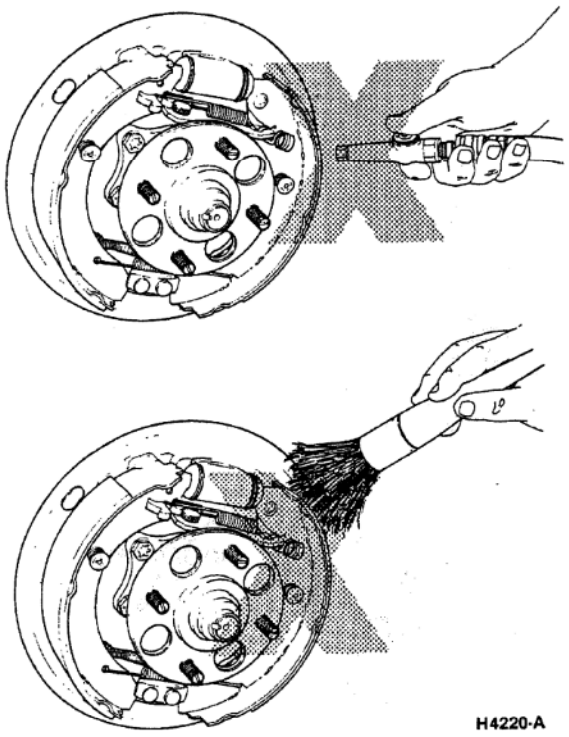
Before the cam can rotate, the brake pedal must be pushed and the linings must move outward against the brake drum. As the primary shoe moves, the gap between the shoe and the self adjuster closes. If the gap closes just as the shoes contact the drum, the adjustment is correct and no motion of the cam occurs. If the gap has closed, but the shoes have not contacted the drum, further outward movement of the shoe will cause the cam to rotate to a new position relative to the fixed wheel. As the shoe returns inward, the adjuster cam spring will immediately pull the cam into contact with the fixed wheel. The cam and the shoe are thereby held in the new adjusted position.

PARKING BRAKE



The parking brake cable is attached to the secondary brake through a lever. When the parking brake is applied, the lever forces the secondary shoe outward against the drum. The pushing action used to apply the secondary shoe is transmitted through the parking brake strut to the primary shoe.

CLEANING



WARNING: Breathing asbestos dust is hazardous to your health.

Dust and dirt present on a brake and clutch assembly may contain asbestos fibers that are hazardous to your health when made airborne by cleaning with compressed air or by dry brushing.

Wheel brake assemblies should be cleaned using a vacuum cleaner recommended for use with asbestos fibers, such as Rotunda Model 091-00001, or equivalent. Dust and dirt from the vacuum should be disposed of in a manner that prevents dust exposure, such as sealed bags. The bag must be labeled per OSHA instructions and the trash hauler notified as to the bag's contents.

If a vacuum suitable for asbestos is not available, cleaning should be done wet. If dust generation is still possible, technicians should wear government-approved toxic dust purifying respirators.

Grinding or sanding on brake linings, pads, rotors, drums or clutch facings should be done while using properly exhaust-ventilated equipment.

OSHA requires areas where asbestos dust generation is possible to be isolated and posted with warning signs. Only technicians concerned with performing brake service should be present in the area.

Denatured alcohol is acceptable for cleaning component parts provided the parts are completely air dried and coated with brake fluid before installation.

CAUTION: Do not use denatured alcohol for flushing system or cleaning assemblies where alcohol could be trapped and subsequently contaminate brake fluid. Contaminated fluid may cause eventual failure of rubber components in the system.

To remove brake fluid contamination, clean all parts except the brake lining with denatured alcohol. Do not attempt to clean contaminated brake lining. Contaminated brake lining must be replaced.

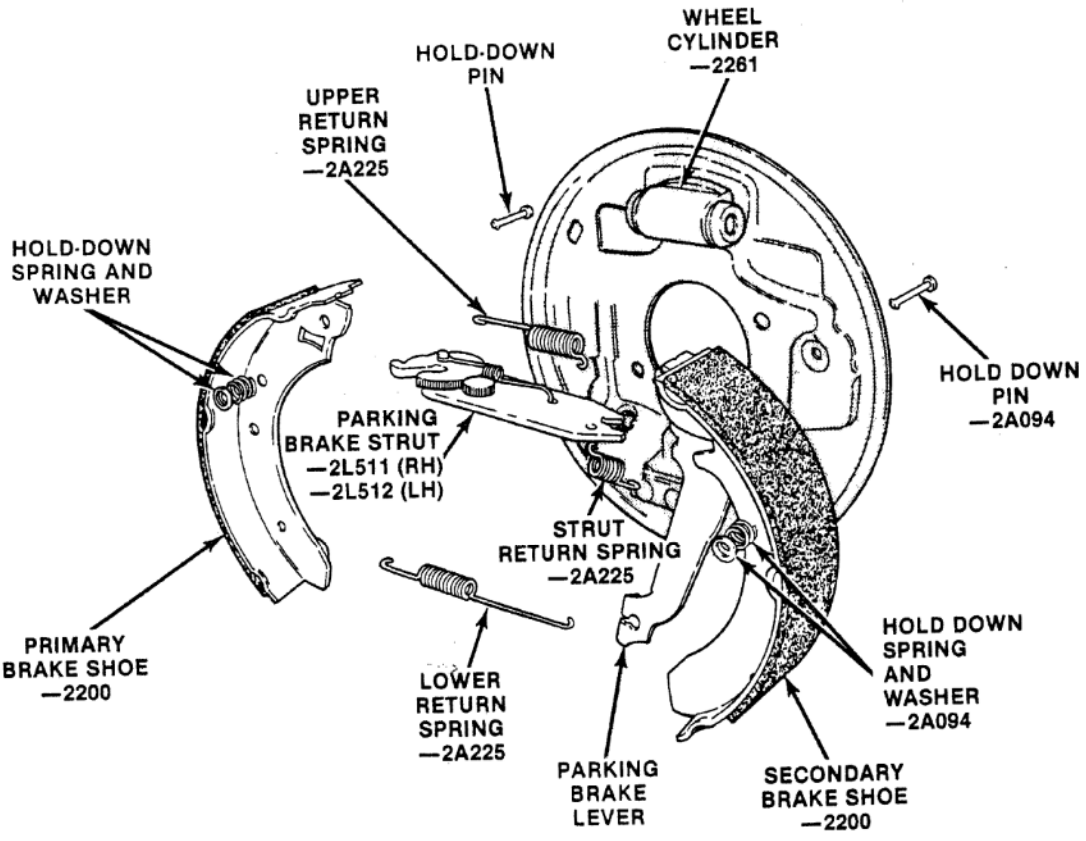
New brake drums are given a light coating of rustproofing oil to prevent the formation of rust on the braking surfaces while the drums are in storage. Carefully remove this rust-proofing oil before placing the drum in service to prevent any of this oil from getting on the brake shoe facings. To ensure the cleanest possible surface, use a suitable volatile, non-toxic, greaseless type solvent. Do not use gasoline or kerosene as a portion of the diluted oil substance may be left on the braking surface.

NOTE: The original equipment brake shoes contain a carbon compound rather than asbestos. However, this warning is provided in the event the original brake shoes were replaced with shoes containing asbestos or with shoes of unknown composition.

REMOVAL AND INSTALLATION

DRUM BRAKE DISASSEMBLED VIEW

NOTE: When it is necessary to replace linings, they must also be replaced on the opposite side of the vehicle.

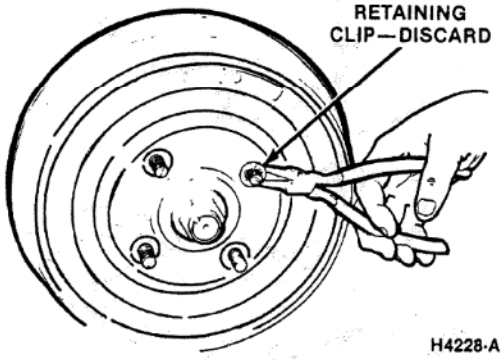


REMOVAL AND INSTALLATION

BRAKE SHOES

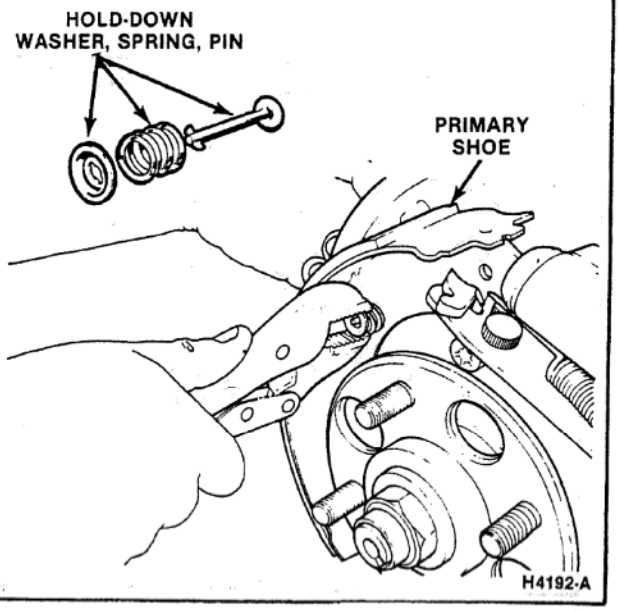
Removal

1. Remove the wheel and brake drum. Discard the brake drum retaining clip.

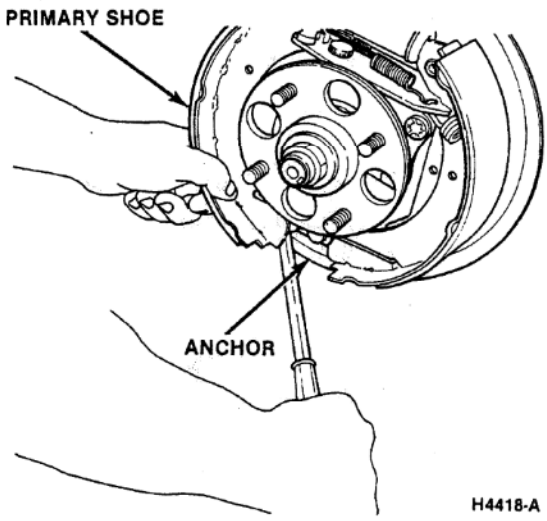


NOTE: Should difficulty be experienced in removal of the brake drum due to the action of the automatic self-adjuster mechanism, the self-adjuster may be released using the procedure outlined in this section.

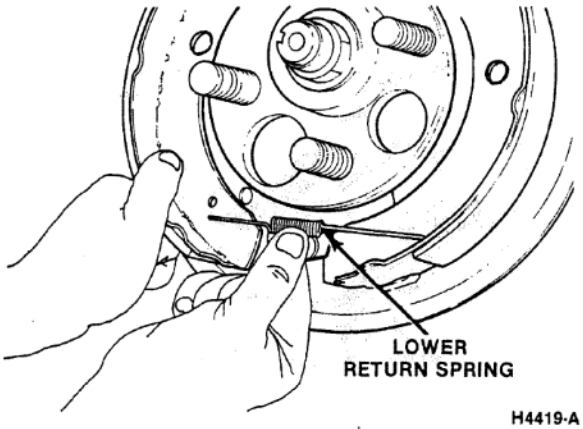
2. Remove both brake shoe hold-down springs. To prevent rotation during removal, hold each hold-down pin head with a finger behind the backing plate.



3. Pry the lower end of the primary shoe from its position against the anchor.



4. Remove the lower return spring.

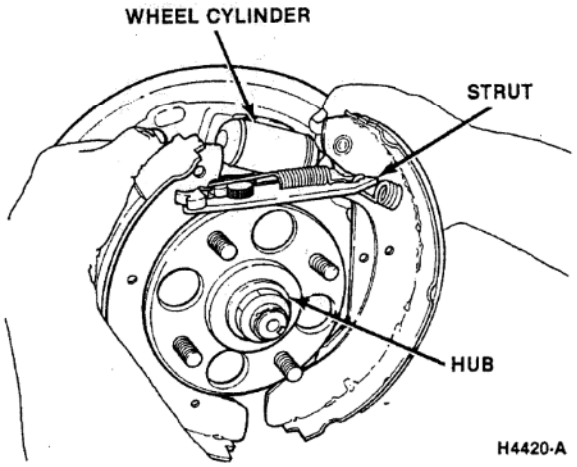


REMOVAL AND INSTALLATION

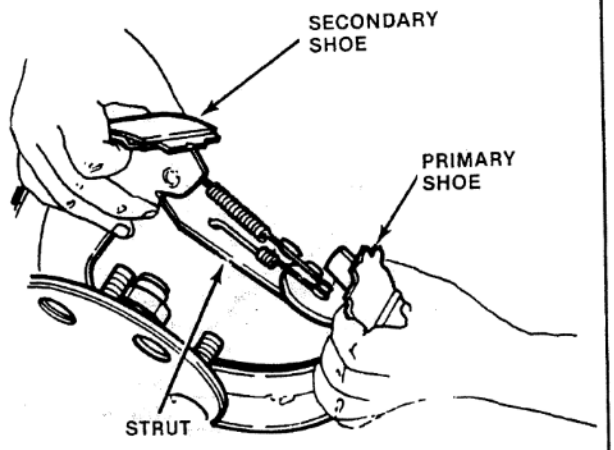
BRAKE SHOES

Removal (Continued)

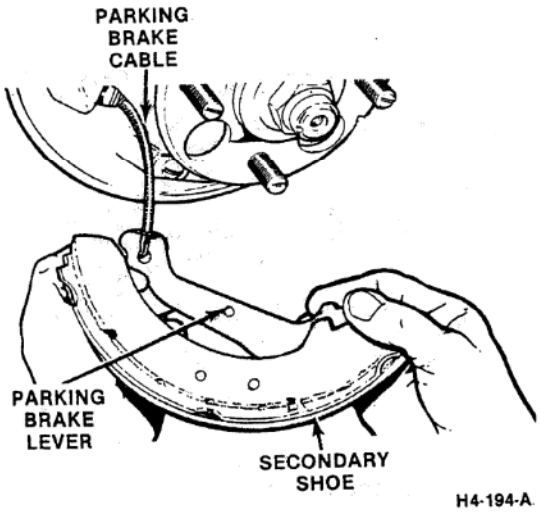
5. Remove the shoes and strut by passing the strut between the wheel cylinder and the hub.



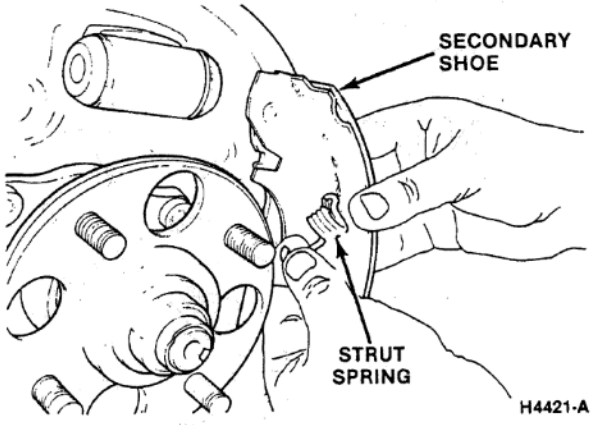
6. Pull the top of the primary shoe away from the secondary shoe to disconnect the strut from the secondary shoe.



7. Disconnect the parking brake cable from the secondary shoe lever.



8. Remove the strut return spring from the secondary shoe.

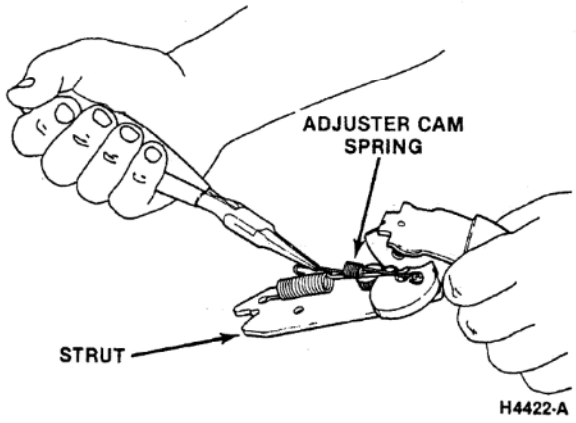


REMOVAL AND INSTALLATION

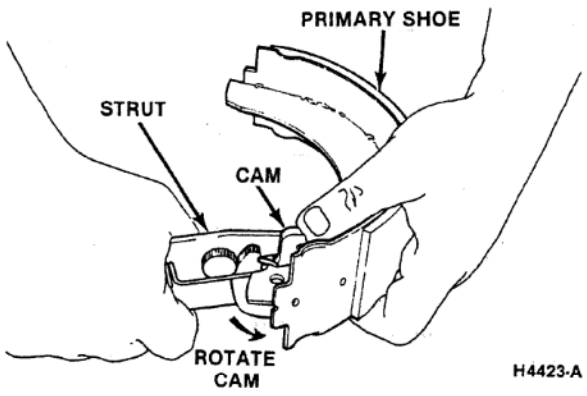
BRAKE SHOES

Removal (Continued)

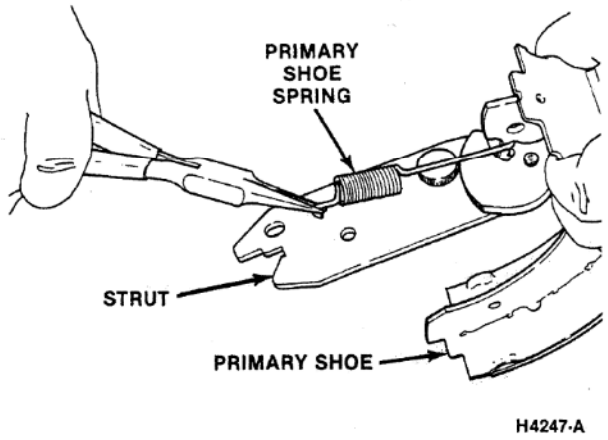
9. Remove the adjuster cam spring.



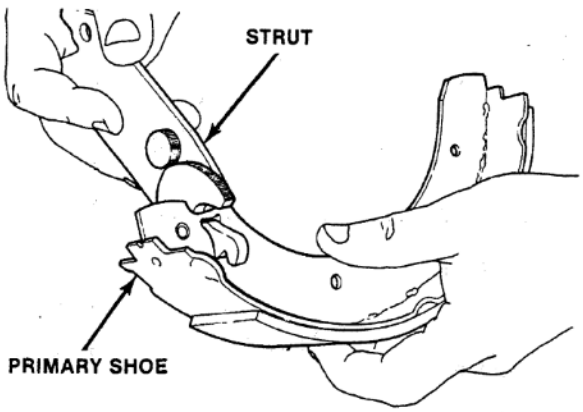
10. Pull the primary shoe away from the strut while rotating the cam to the fully released position.



11. Remove the primary shoe spring.

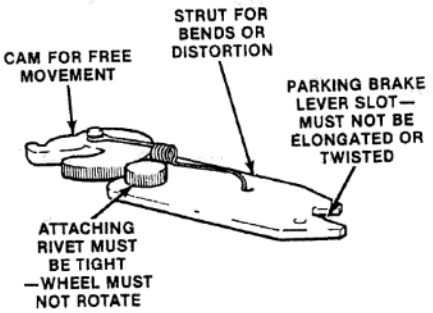
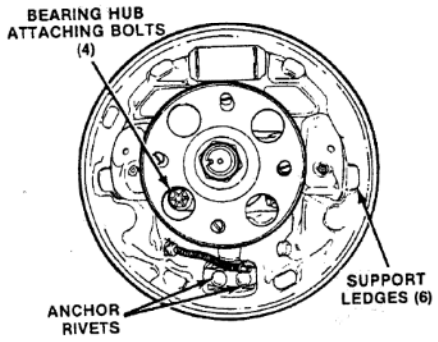
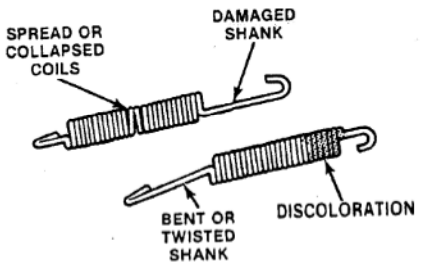


12. Remove the primary shoe from the strut.



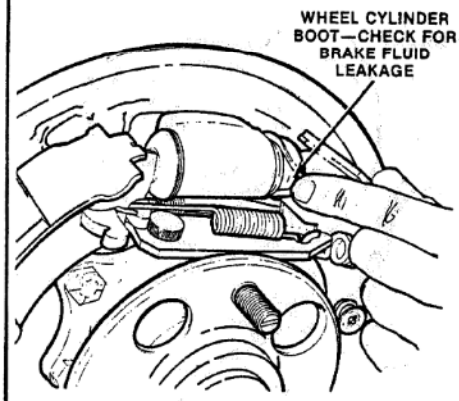
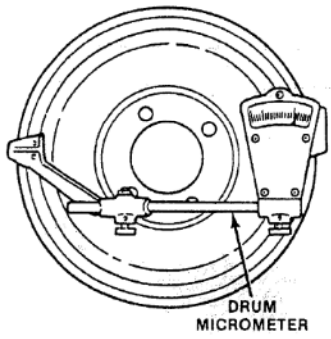
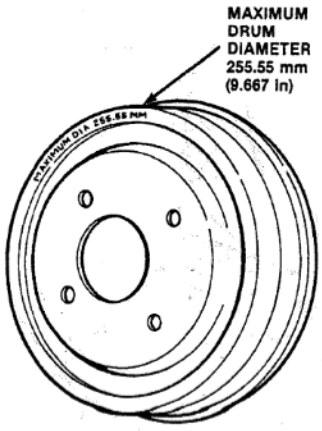
REMOVAL AND INSTALLATION

DRUM BRAKES
COMPONENT INSPECTION CHART

COMPONENT	CHECK FOR
SELF ADJUSTER  	• Free movement of cam — If a dragging or binding condition cannot be corrected, replace the assembly. • Loose or damaged cam pin • Loose or damaged wheel — The wheel must be securely peened to the strut. • Bends, twists or other distortion • Elongated or twisted parking brake lever slot • Damaged or worn teeth on cam and wheel • Distortion or damage that may affect proper alignment of the shoes
BACKING PLATE  	• Loose anchor plate rivets — The rivets must be tight and securely peened. • Deep grooves in the backing plate ledges that could restrict shoe movement — If grooves exist after polishing, the backing plate must be replaced. Any attempt to remove the grooves by grinding may result in improper shoe-to-drum contact. • Loose bearing hub attaching bolts — If necessary, tighten the bolts to 52 to 64 N·m (45 to 48 lb-ft).
SPRINGS  	• Separated or twisted coil • Twisted, bent or damaged shanks • Discoloration — Discoloration is a sign of brake overheating. Overheated springs lose some tension and should be replaced. (CH 4431-A)

REMOVAL AND INSTALLATION

DRUM BRAKES
COMPONENT INSPECTION CHART (Continued)

COMPONENT	CHECK FOR
WHEEL CYLINDERS  	• Leaks — Wheel cylinders should not be disassembled unless they are leaking. To check, carefully pull lower edges of wheel cylinder boots away from cylinders to see if the interior of the cylinder is wet with brake fluid. Excessive fluid at this point indicates leakage past the piston cups and a need for wheel cylinder overhaul. A slight amount of fluid is nearly always present and acts as a lubricant for the piston. If evidence of leakage is noted, the cylinder should be disassembled, inspected and overhauled. • Looseness — If necessary, tighten the attaching bolts to 7 to 10 N·m (5 to 7 lb-ft).
BRAKE DRUMS   	A brake drum should be visually inspected and measured with an accurate drum micrometer. Before making an inspection or measurement, remove grease, brake fluid, and similar contaminants from the brake drums, using denatured alcohol. Best shop practice requires measuring every drum with a drum micrometer regardless of visual inspection. The drum micrometer is set to the drum diameter and indicates the amount and type of wear. Measure the diameter at various points, 45 degrees apart around the circumference, and at the bottom of the deepest groove to determine if the drum requires replacement. **CAUTION: If the braking surface diameter has worn in excess of the maximum diameter, shown in cast figures on the outside of the drum, replace the drum.**

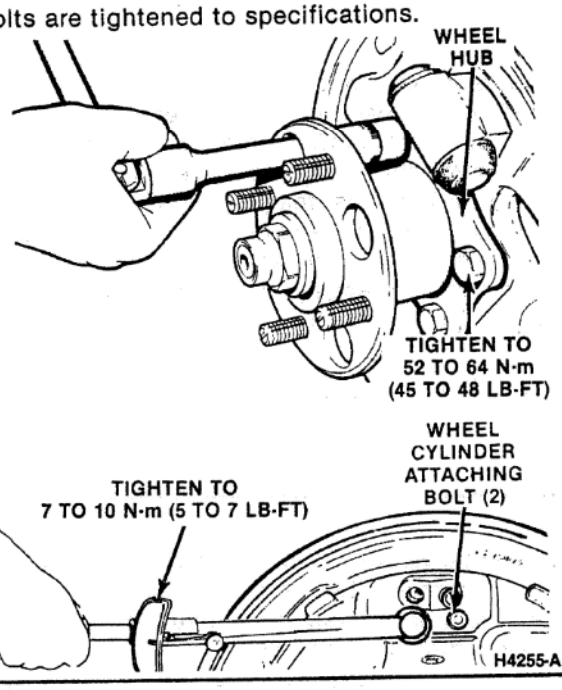
(CH 4431-A)

REMOVAL AND INSTALLATION

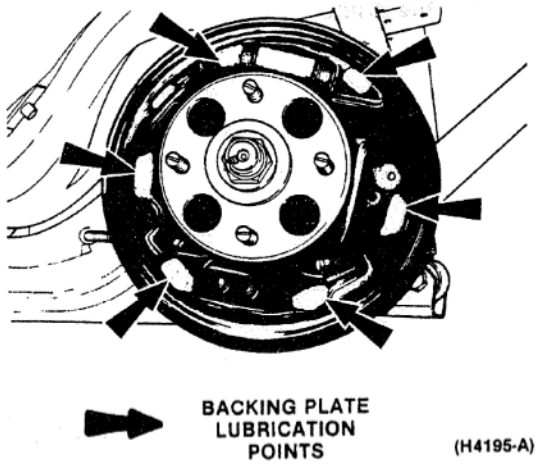
BRAKE SHOES

Installation

NOTE: Before installing the brake shoes make sure the wheel hub and wheel cylinder attaching bolts are tightened to specifications.

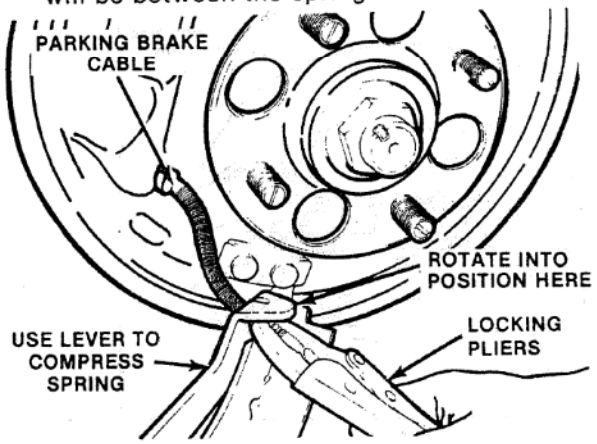


1. Apply a light coating of the grease supplied with the new brake shoes or high temperature grease D7AZ-19590-A, or equivalent, to the support ledges where the brake shoes contact the backing plate.

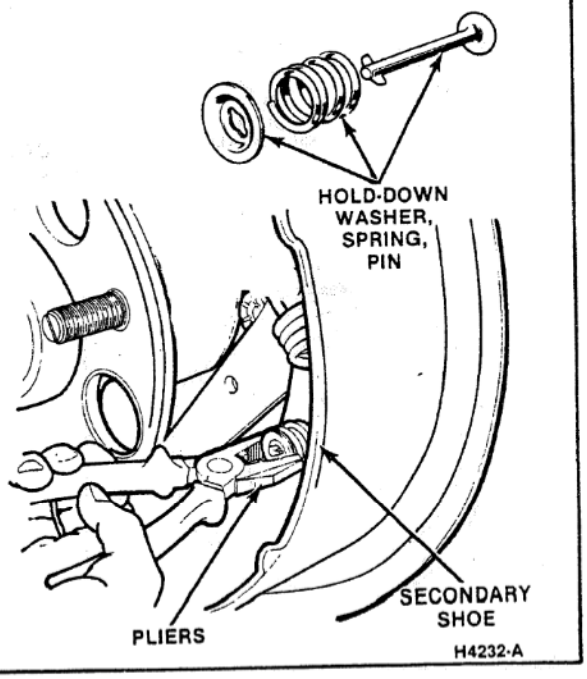


2. Connect the parking brake cable to the secondary shoe lever. To connect the cable, position the cable end through the lever, grip the cable end with locking type pliers and push the lever against the spring until it can be rotated over the cable.

   When properly installed, the plastic washer will be between the spring and the lever.



3. Position the secondary shoe and install the hold-down spring.

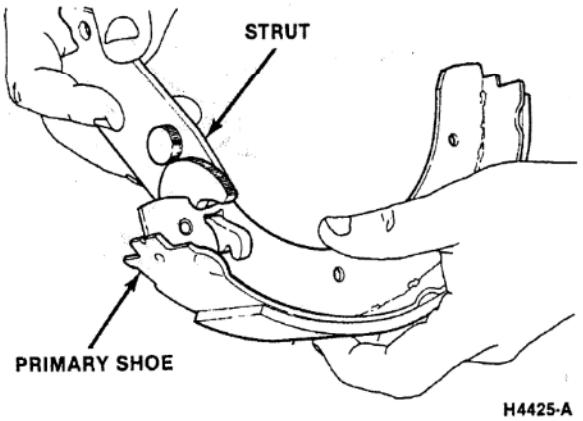


REMOVAL AND INSTALLATION

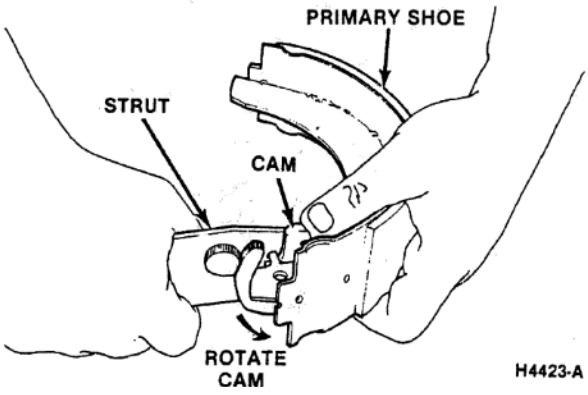
BRAKE SHOES

Installation (Continued)

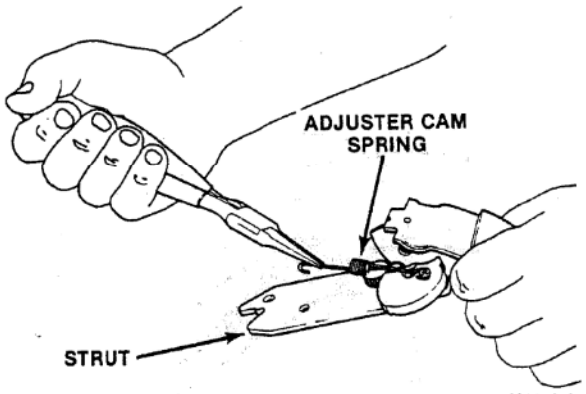
4. Install the strut and cam assembly on the primary shoe.



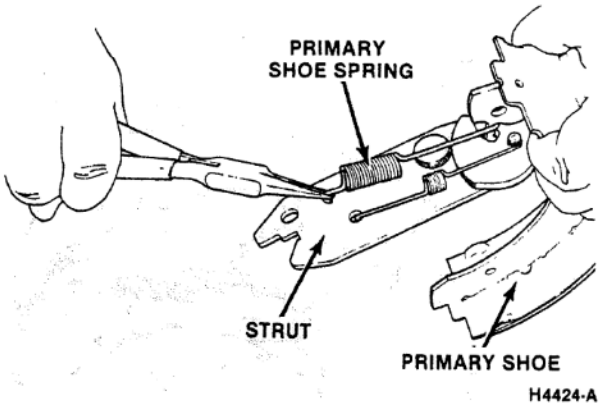
5. Rotate the cam to the fully released position.



6. Install the adjuster cam spring.



7. Install the primary shoe spring.

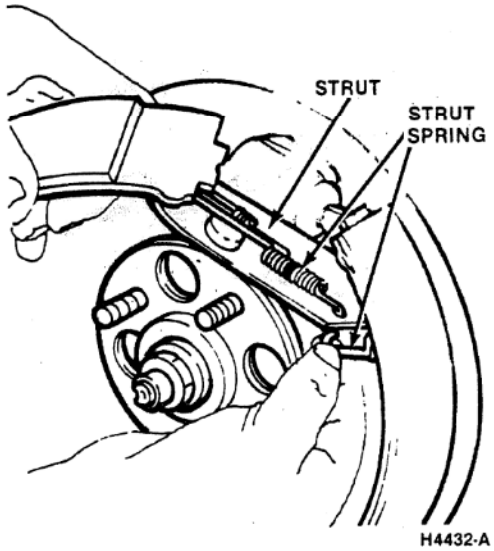


REMOVAL AND INSTALLATION

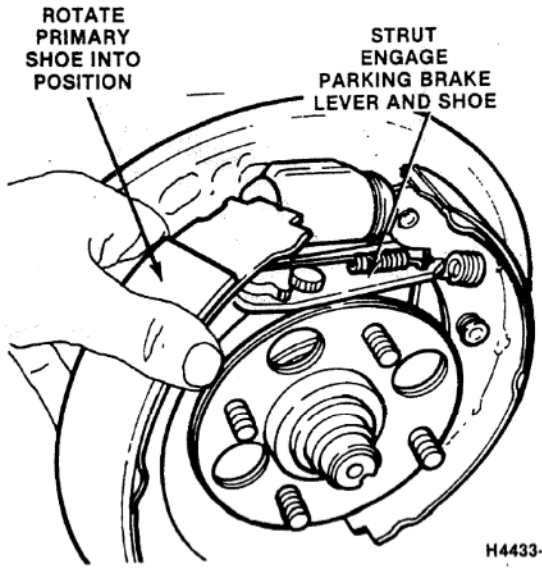
BRAKE SHOES

Installation (Continued)

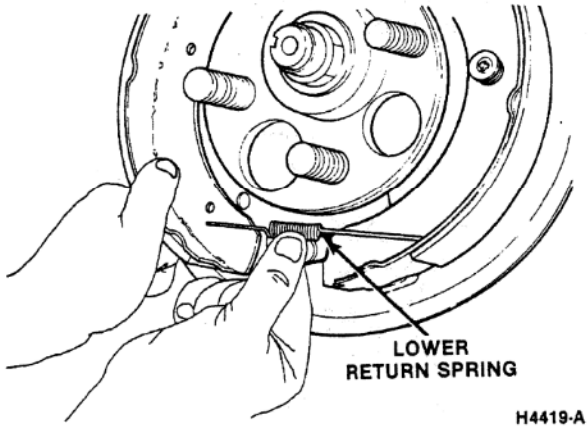
8. Install the strut spring in the secondary shoe and then in the strut.



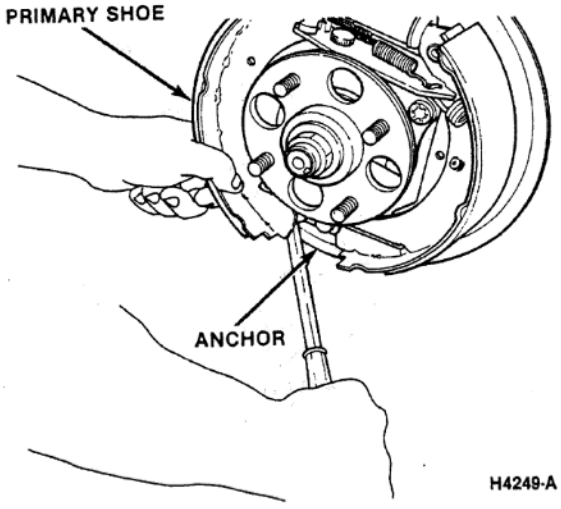
9. Place the strut on the parking brake lever and move the primary shoe toward the backing plate. The strut will then "click" into place over the parking brake lever and secondary shoe web.



10. Install the lower shoe spring with the longer leg on the secondary shoe.



11. Pry the lower end of the primary shoe into position against the anchor while holding the top of the shoe against the backing plate, in contact with the cylinder piston. Take care not to damage the cylinder boot.

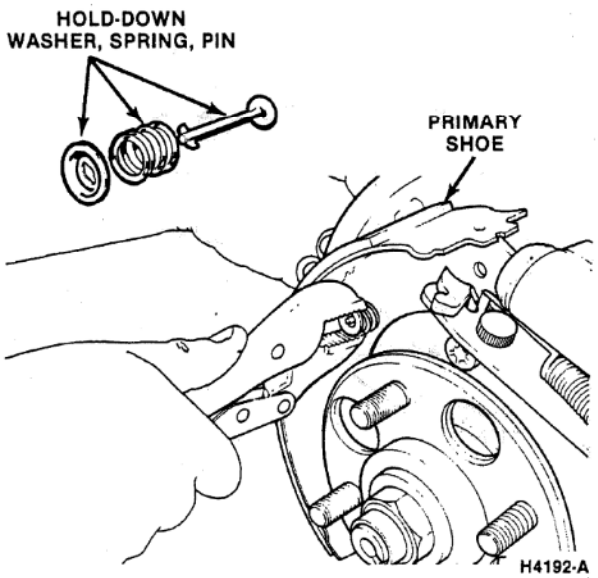


REMOVAL AND INSTALLATION

BRAKE SHOES

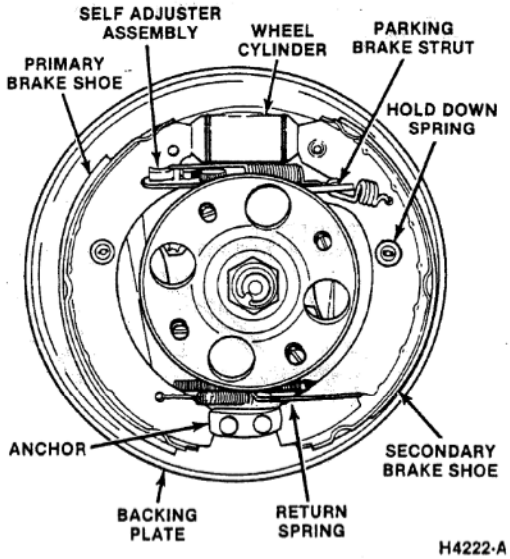
Installation (Continued)

12. Install the primary shoe hold-down pin, spring, and washer.

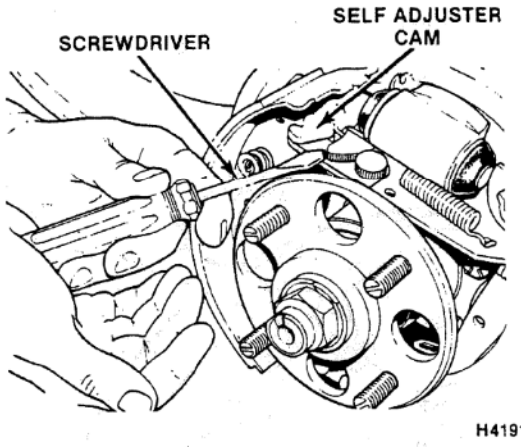


13. Make sure the heel of each brake shoe is located behind the anchor plate.

    Check each brake component for proper installation. The following illustration can be used as a guide.



14. If necessary, push the adjuster cam to the release position.

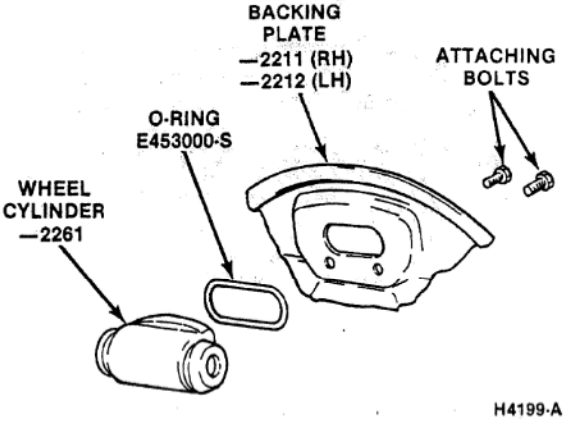


15. Install both brake drums.
16. Push the brake pedal hard twice to set the self-adjuster cam position. The cam will make a ratcheting sound as it resets.
17. Adjust the parking brake cable as necessary, as described in Section 12-70.

WHEEL CYLINDER

Removal

1. Remove the wheel and brake drum.

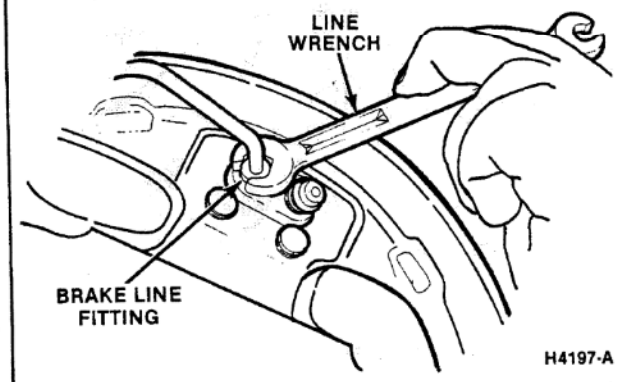


REMOVAL AND INSTALLATION

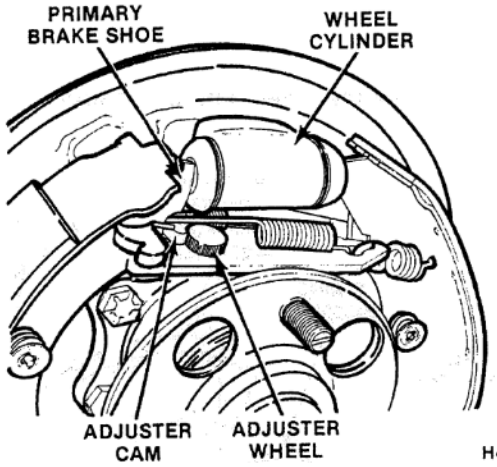
WHEEL CYLINDER

Removal (Continued)

2. Disconnect the wheel cylinder brake line. Plug the line to prevent loss of fluid and entry of dirt.



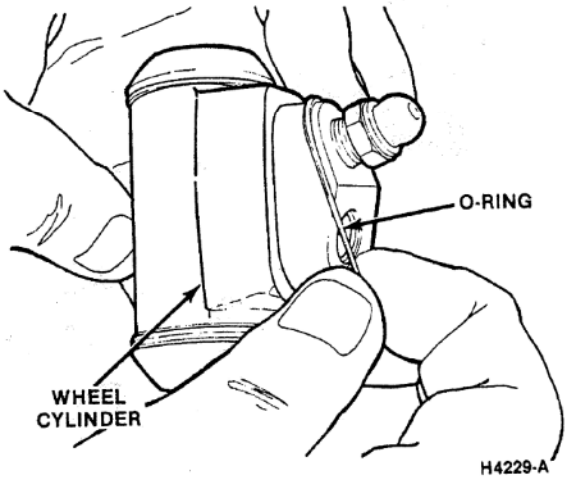
3. Pull the primary shoe away from the wheel cylinder. The self-adjuster cam will rotate outward to hold the brake shoes away from the wheel cylinder.



4. Remove the wheel cylinder attaching bolts, the wheel cylinder, and the O-ring.

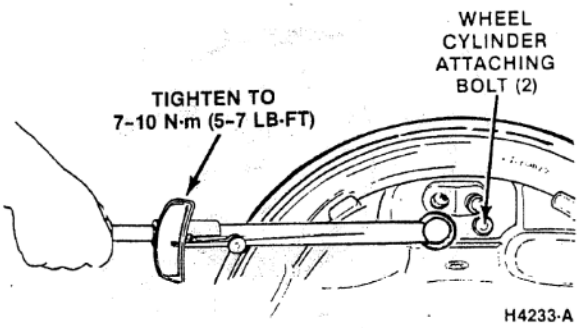
Installation

1. Install the O-ring on the wheel cylinder.



2. Position the wheel cylinder and install the attaching bolts.

   Tighten the attaching bolts to 7 to 10 N·m (5 to 7 lb-ft).

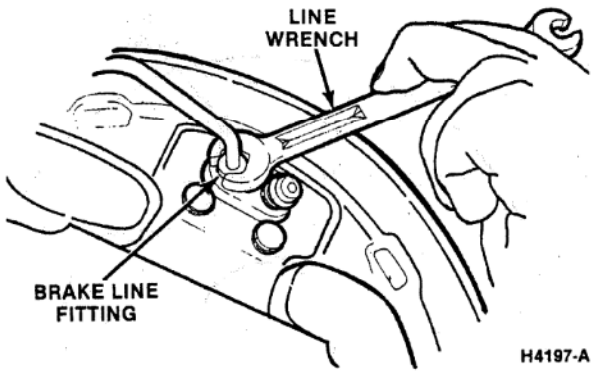


REMOVAL AND INSTALLATION

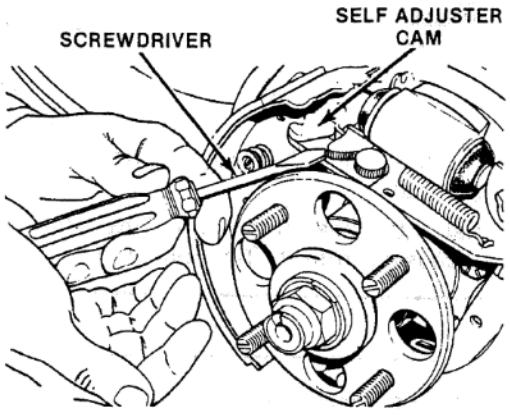
WHEEL CYLINDER

Installation (Continued)

3. Connect the brake line.



4. Using a screwdriver, push the adjuster cam to the released position.



5. Install the brake drum.
6. Bleed the rear brakes.

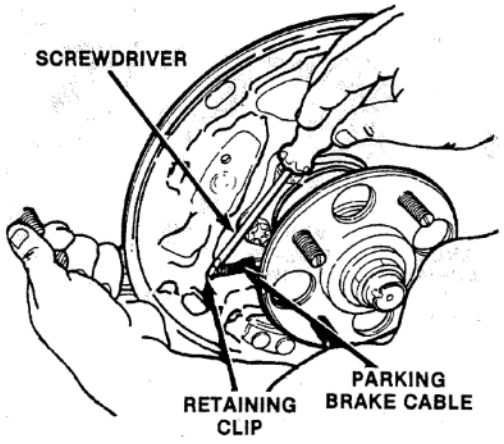
NOTE: If a pressure bleeder is used, push the brake pedal hard twice to set the self adjuster cam position. The cam will make a ratcheting sound as it resets.

7. Install the wheel.

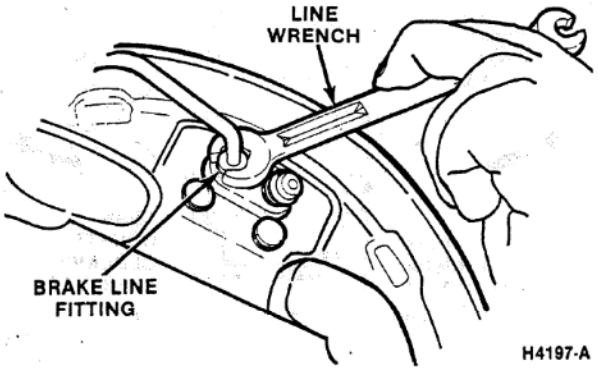
BACKING PLATE

Removal

1. Remove the wheel and brake drum.
2. Remove the brake shoes. If necessary, refer to the procedure elsewhere in this section.
3. Spread the retaining clip and pull the parking brake cable out of the backing plate.



4. Disconnect the wheel cylinder brake line. Plug the line to prevent loss of fluid and entry of dirt.

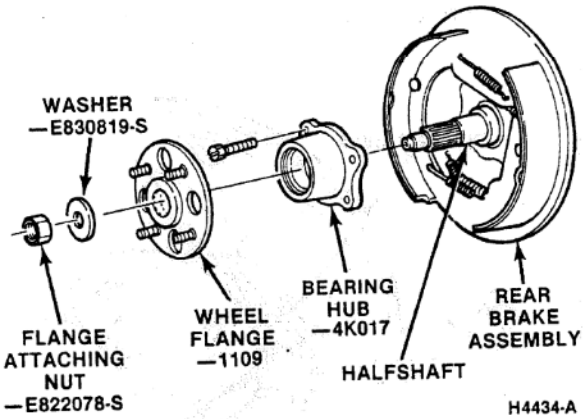


REMOVAL AND INSTALLATION

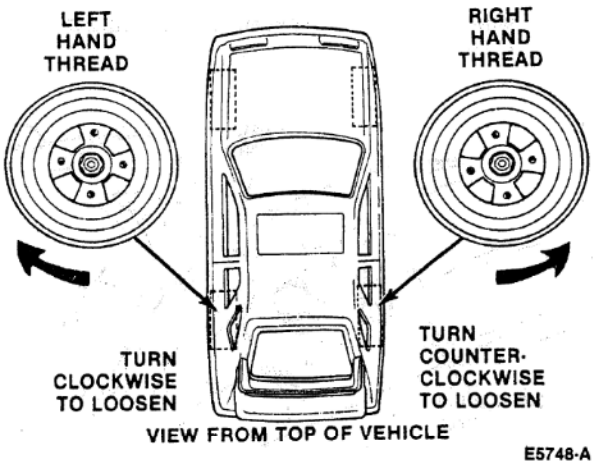
BACKING PLATE

Removal (Continued)

5. Remove the wheel flange and bearing hub. If necessary, refer to Section 11-15.



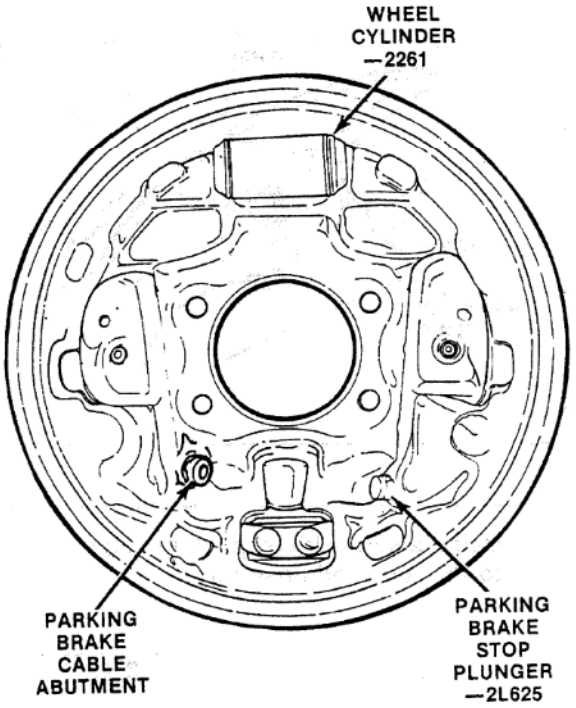
NOTE: The wheel flange attaching nuts are left- and right-hand threaded. The right-hand thread is located on the right side of the vehicle.



6. Remove the backing plate.

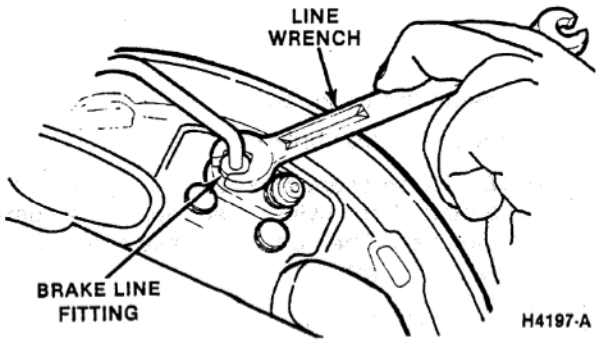
Installation

1. If the backing plate is being replaced, transfer the wheel cylinder, parking brake stop plunger to the new backing plate.



2. Position the backing plate over the halfshaft.
3. Install the bearing hub and wheel flange. If necessary, refer to Section 11-15.

4. Connect the brake line.

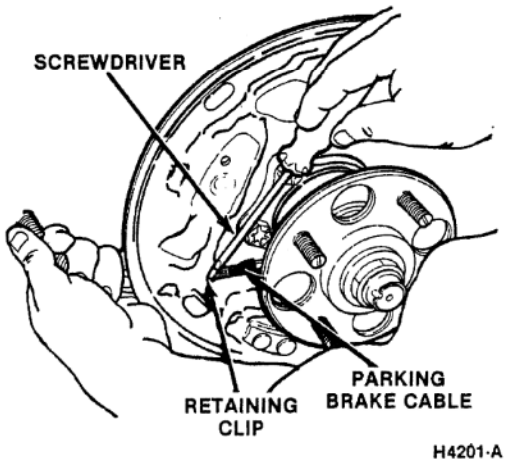


REMOVAL AND INSTALLATION

BACKING PLATE

Installation (Continued)

5. Push the parking brake cable through the backing plate. Make sure the cable retaining clip is engaged on inner face of cable abutment.

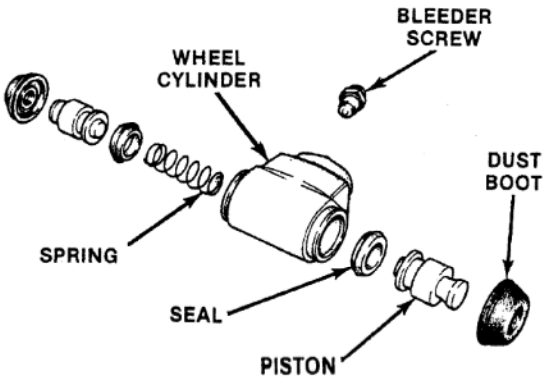


H4201-A

6. Install the brake shoes. If necessary, refer to the procedure elsewhere in this section.
7. Install the brake drum and wheel. Tighten the wheel attaching nut to 70 to 100 N·m (55 to 70 lb-ft).
8. Bleed the brakes. If necessary, refer to Section 12-80.

DISASSEMBLY AND ASSEMBLY

WHEEL CYLINDER



H4209-A

Disassembly

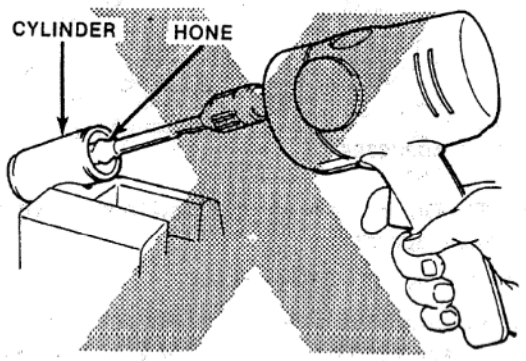
1. Remove the dust boots, pistons and spring. Discard the boots.
2. Remove the bleeder screw.
3. Remove the seals from the pistons and discard.
4. Wash the cylinder and pistons with clean denatured alcohol and dry with compressed air. Do not use kerosene or gasoline for cleaning wheel cylinder parts. The use of these as solvents or any other with a trace of mineral oil will damage rubber parts.
5. Make sure the bleeder holes in the cylinder and bleeder screw are open.
6. Inspect the pistons for scratches, scoring, or other damage. Replace if necessary.

Inspection

Inspect cylinder bore for scores, scratches, or corrosion. Light scratches or slightly corroded spots may be polished out with crocus cloth. Never use emery cloth or sandpaper. If scratches or corrosion are too deep to be polished out, replace the cylinder.

Staining should not be confused with corrosion. Corrosion can be identified as pits or excessive roughness.

Do not hone wheel cylinder bores. When the wheel cylinders are overhauled, it is recommended that the cylinder body be replaced rather than "cleaned up" by honing the bore. Wheel cylinder bores have a hard, highly polished surface. Honing will destroy this surface, leaving a softer and rougher surface which will cause more rapid wear of rubber cups.



H4234-A

DISASSEMBLY AND ASSEMBLY

WHEEL CYLINDER (Continued)

Assembly

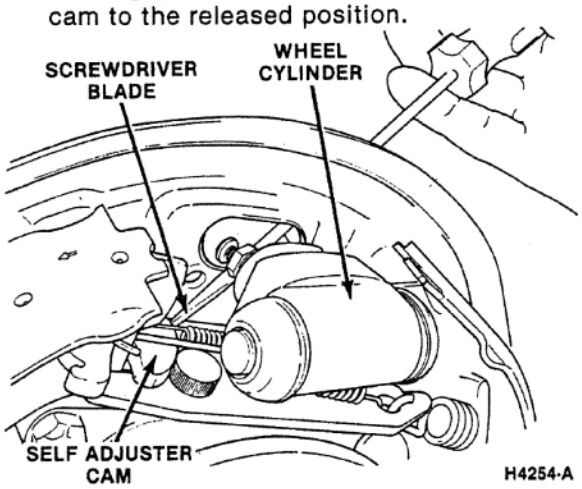
1. Install the seals in the piston grooves.
2. Lubricate the cylinder bore and pistons with heavy-duty brake fluid.
3. Install the spring, pistons, and boots.
4. Install the bleeder screw.

GENERAL SERVICE PROCEDURES

Brake Drum Removal

Should difficulty be experienced in removal of the brake drums due to the action of the automatic self-adjuster mechanism, the self-adjuster may be released using the procedure outlined below.

1. Remove the wheel cylinder attaching bolts.
2. Push the wheel cylinder away from the backing plate to provide an access opening in the backing plate.
3. Insert a thin bladed screwdriver through the backing plate and rotate the self-adjuster cam to the released position.



NOTE: Drum is shown removed to allow view of release operation.

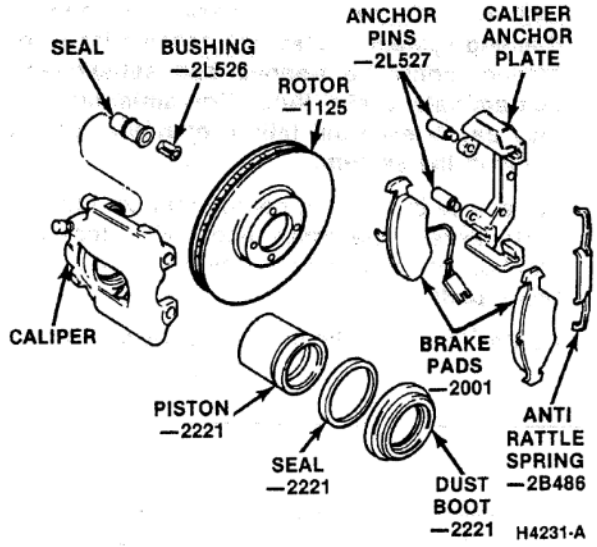
4. Remove the brake drum.
5. Position the wheel cylinders and install the attaching bolts. Tighten the attaching bolts to 7 to 10 N·m (5 to 7 lb-ft).

SECTION 12-20 DISC BRAKES

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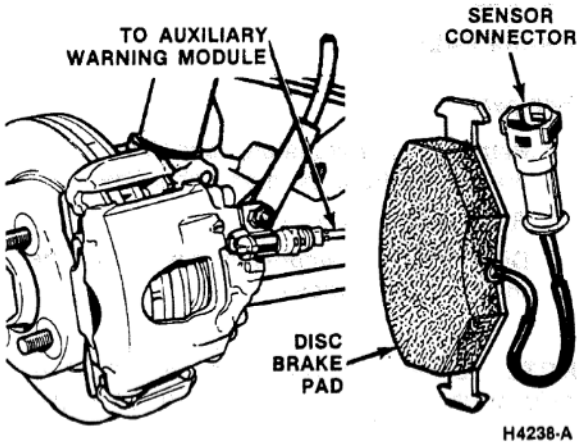
DESCRIPTION



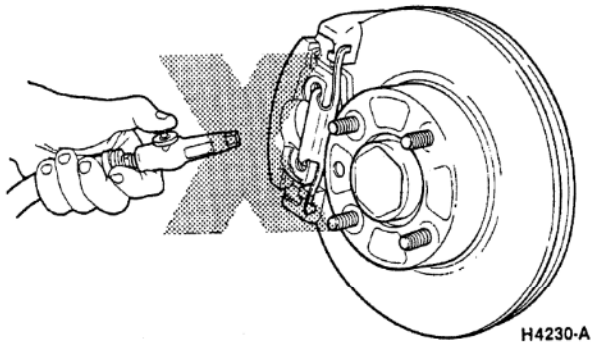
Stopping power for the XR4Ti is provided by front disc brakes and rear drum brakes. The disc brake is a single piston, floating caliper design. The caliper assembly slides on two anchor pins which also act as the attaching bolts between the caliper and anchor plate. The caliper assembly consists of a nodular iron housing, the brake pads and a sealed piston. A molded rubber dust boot is installed around the outer end of the piston to keep dirt and moisture from entering the caliper bore. A seal is located in the caliper bore to prevent leakage of hydraulic fluid between the piston and caliper bore. The piston seal also pulls the piston away from the rotor when the brakes are released.

The rotor is a cast iron, ventilated design with the cooling fins sandwiched between the braking surfaces. The wheel hub is not an integral part of the rotor.

An indicator light, located in the instrument cluster, will come on when either inboard brake pad has worn to a thickness of 1.5 mm. If the light is on, remove the front wheels and check the pad thickness. Worn pads must be replaced. If the pads are not worn, check for a problem in the indicator light circuit.



CLEANING


H4230-A

WARNING: Breathing asbestos dust is hazardous to your health.

Dust and dirt present on a brake and clutch assembly may contain asbestos fibers that are hazardous to your health when made airborne by cleaning with compressed air or by dry brushing.

Wheel brake assemblies should be cleaned using a vacuum cleaner recommended for use with asbestos fibers, such as the Rotunda Model 091-00001 Brake Service Vacuum, or equivalent. Dust and dirt from the vacuum should be disposed of in a manner that prevents dust exposure, such as sealed bags. The bag must be labeled per OSHA instructions and the trash hauler notified as to the bag's contents.

If a vacuum suitable for asbestos is not available, cleaning should be done wet. If dust generation is still possible, technicians should wear government-approved toxic dust purifying respirators.

Grinding or sanding on brake linings, pads, rotors, drums or clutch facings should be done while using proper exhaust-ventilated equipment.

OSHA requires areas where asbestos dust generation is possible to be isolated and posted with warning signs. Only technicians concerned with performing brake service should be present in the area.

Denatured alcohol is acceptable for cleaning component parts provided the parts are completely air dried and coated with brake fluid before installation.

CAUTION: Do not use denatured alcohol for flushing system or cleaning assemblies where alcohol could be trapped and subsequently contaminate brake fluid. Contaminated fluid may cause eventual failure of rubber components in the system.

To remove brake fluid contamination, clean all parts except the brake pads with denatured alcohol. Do not attempt to clean contaminated brake pads.

Contaminated brake pads must be replaced.

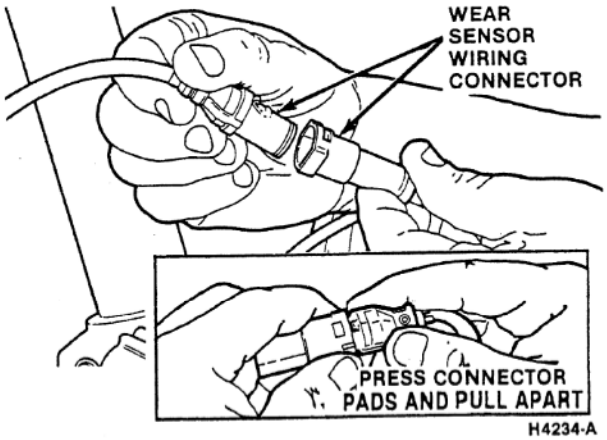
REMOVAL AND INSTALLATION

BRAKE PADS

Removal

1. Remove approximately one-third of the brake fluid from the master cylinder.
2. Remove the wheel.
3. Disconnect the wear sensor wiring connector from the harness.

NOTE: To separate the connector press the pads on the harness connector and pull apart.



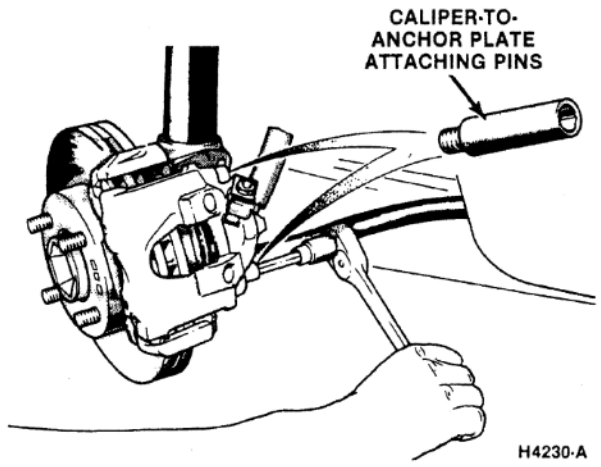
H4234-A

REMOVAL AND INSTALLATION (Continued)

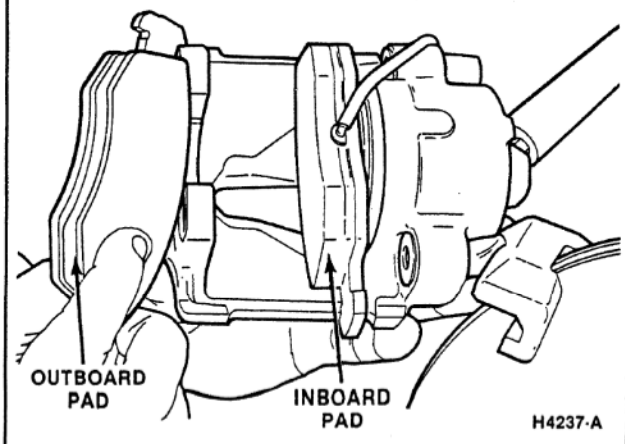
BRAKE PADS

Removal (Continued)

4. Remove the caliper-to-anchor plate attaching pins and lift the caliper assembly off the rotor without disconnecting the hydraulic hose. The anti-rattle spring will fall off when the caliper assembly is removed.

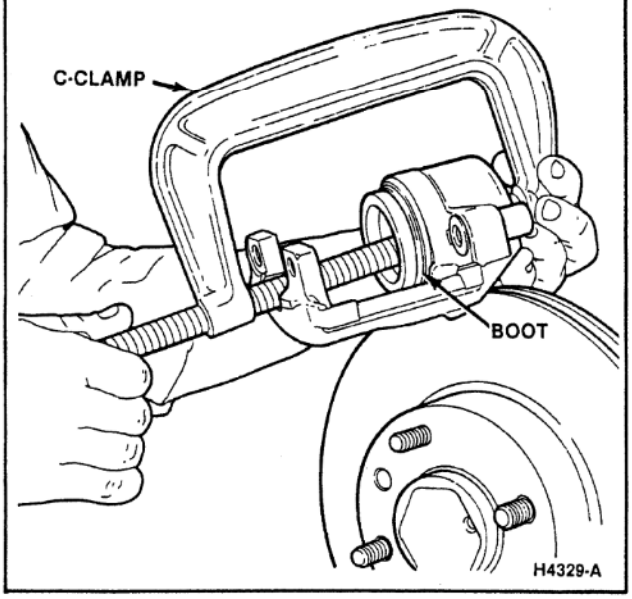


5. Remove the outboard and inboard pads.



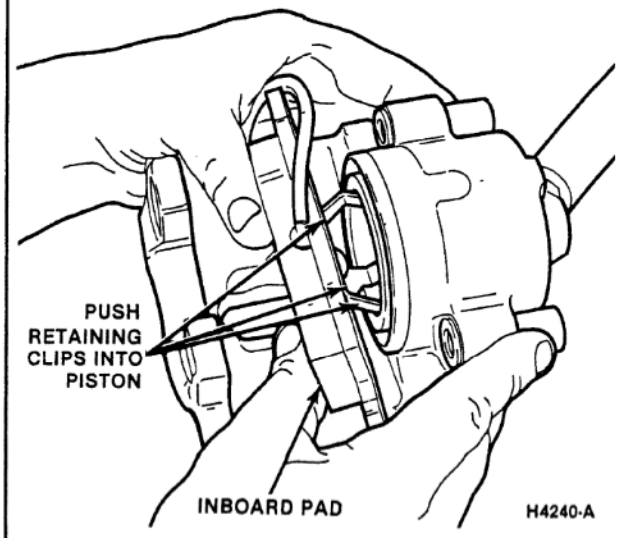
Installation

1. Using a C-clamp or Disc Brake Pad Spreader D79L-2196-A, or equivalent, push the piston back into the caliper bore. Use care to prevent damage to the piston boot.



2. Install the inboard and outboard pads.

   Remove the backing paper from the outboard pad before installation.

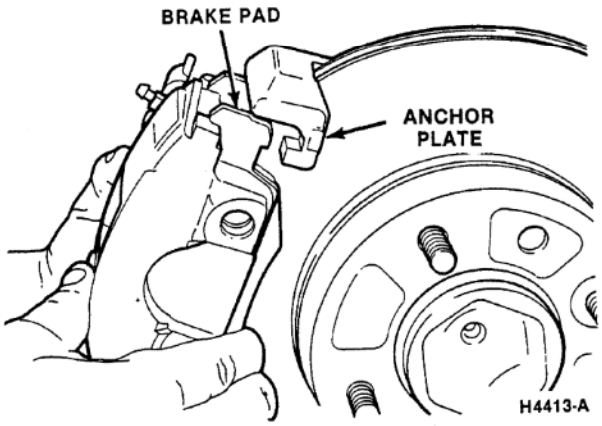


REMOVAL AND INSTALLATION

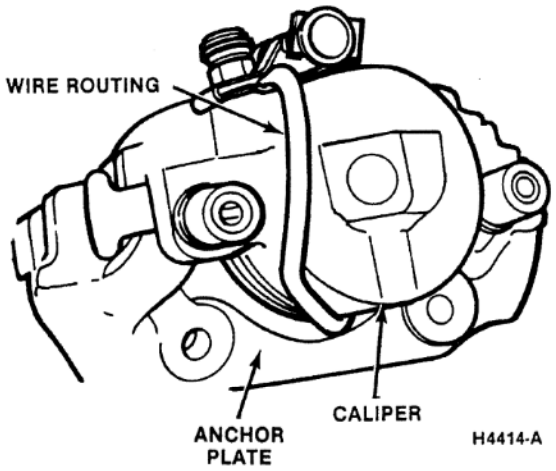
BRAKE PADS

Installation (Continued)

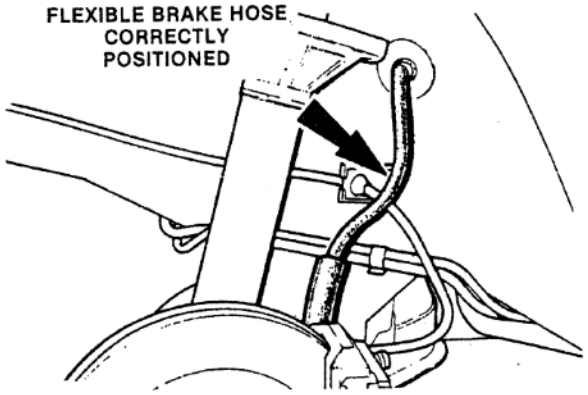
3. Position the caliper over the rotor. Make sure the brake pads are properly engaged on the anchor plate.

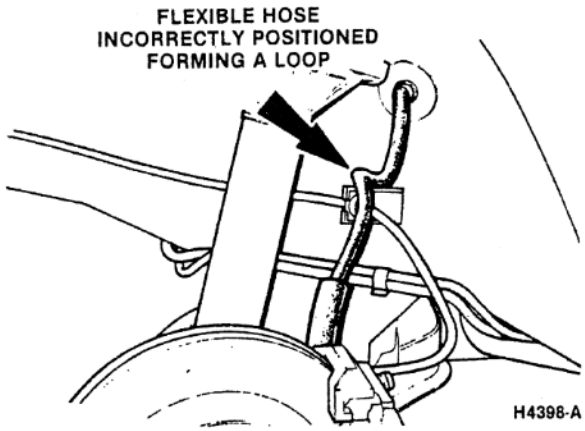


NOTE: The sensor wire must be positioned between the caliper and anchor before installing the caliper attaching bolts.



CAUTION: When the caliper is installed, make sure the brake hose has not been "kinked" by rotation of the caliper. If the caliper is rotated during installation, the "wound-up" or "kinked" condition may cause the flexible hose to form a loop which tightens and rubs against itself when the front wheels are near the steering stops.



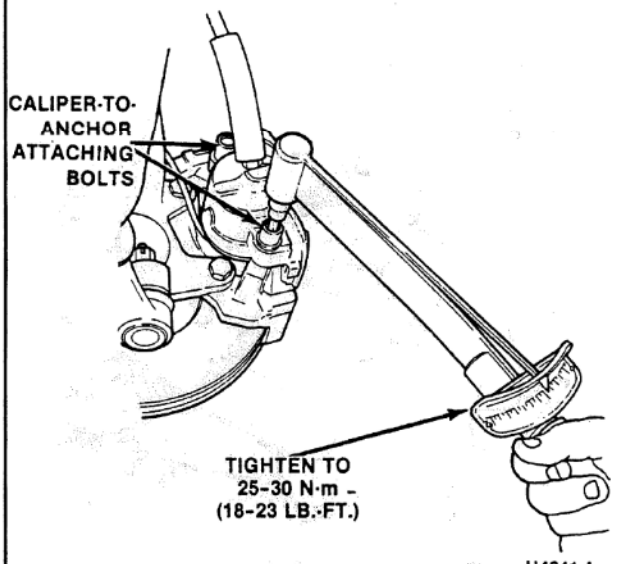


REMOVAL AND INSTALLATION

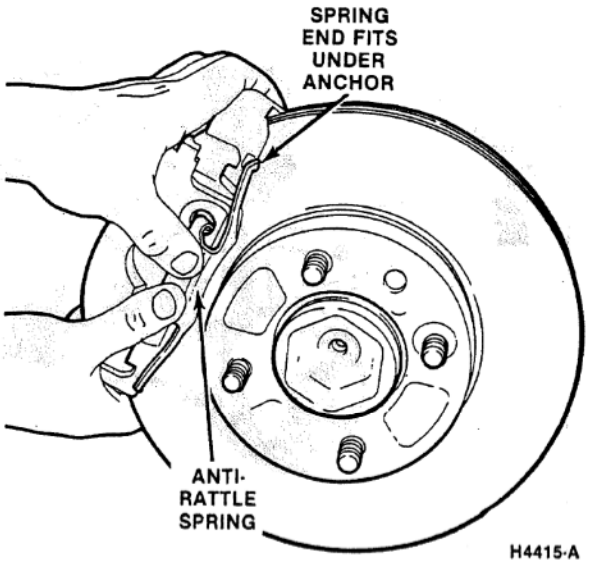
BRAKE PADS (Continued)

Installation (Continued)

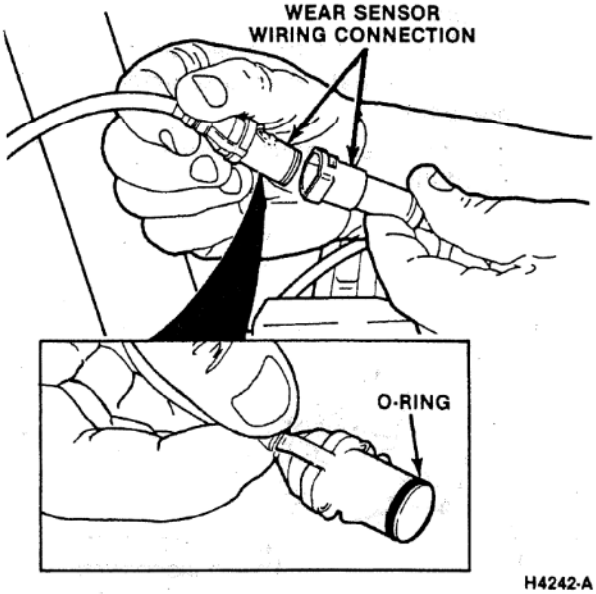
4. Install the caliper-to-anchor attaching pins. Tighten the bolts to 25–30 N·m (18–23 lb. ft.).



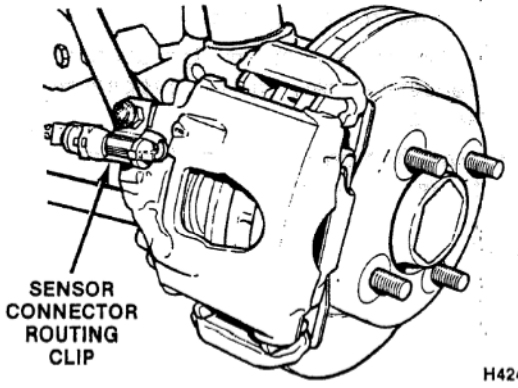
5. Install the anti-rattle spring.



6. Connect the wear sensor. Make sure the O-ring is in position before making the connection.



7. Position the wear sensor wiring connector in the routing clip.
8. Install the wheel.
9. Pump the brake pedal before moving the vehicle. This will position the brake pads.
10. Check the master cylinder fluid level. Add fluid as necessary.



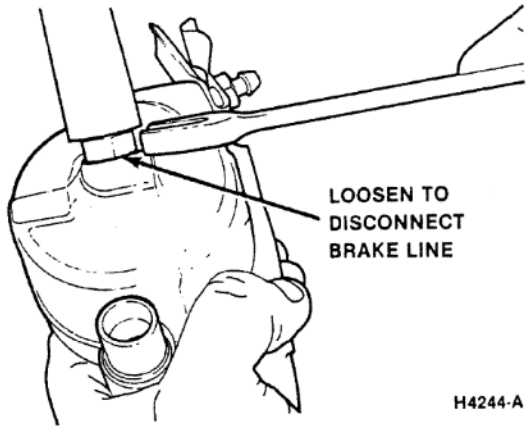
REMOVAL AND INSTALLATION

CALIPER ASSEMBLY

Removal

1. Remove the caliper from the anchor plate. If necessary, refer to the procedure in this section.
2. Loosen the brake hose at the caliper. Rotate the caliper to disconnect from the brake hose.

   Plug the line to prevent loss of fluid and entry of dirt.



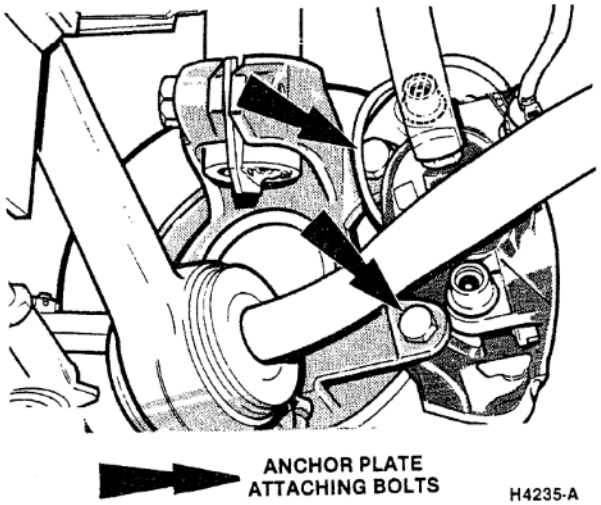
Installation

1. Connect the brake hose to the caliper. Tighten the fitting securely.
2. Install the caliper on the anchor plate. If necessary, refer to the procedure in this section.
3. Bleed the brake system. If necessary, refer to Section 12-80.

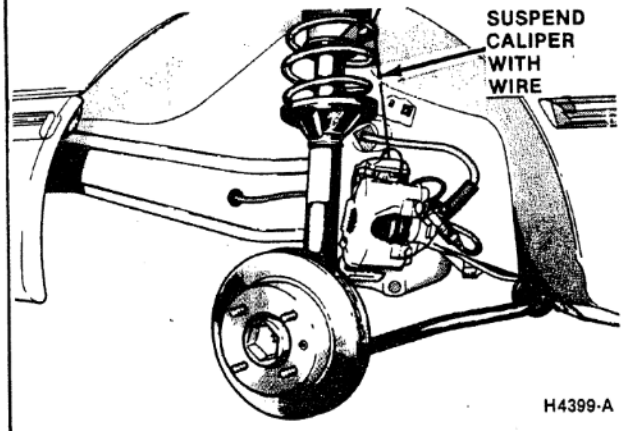
ROTOR

Removal

1. Remove the wheel.
2. Remove the anchor plate attaching bolts.



3. Lift the caliper and anchor plate assembly off the rotor and suspend with wire.

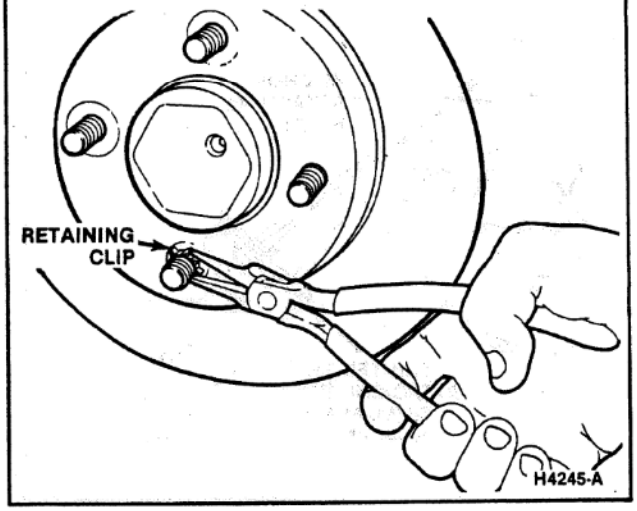


REMOVAL AND INSTALLATION

ROTOR

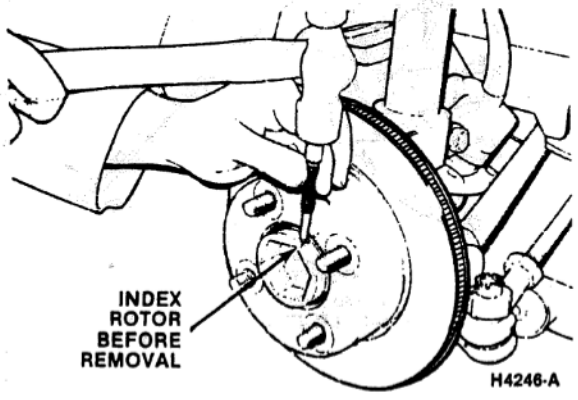
Removal (Continued)

4. Remove the rotor retaining clip and the rotor.



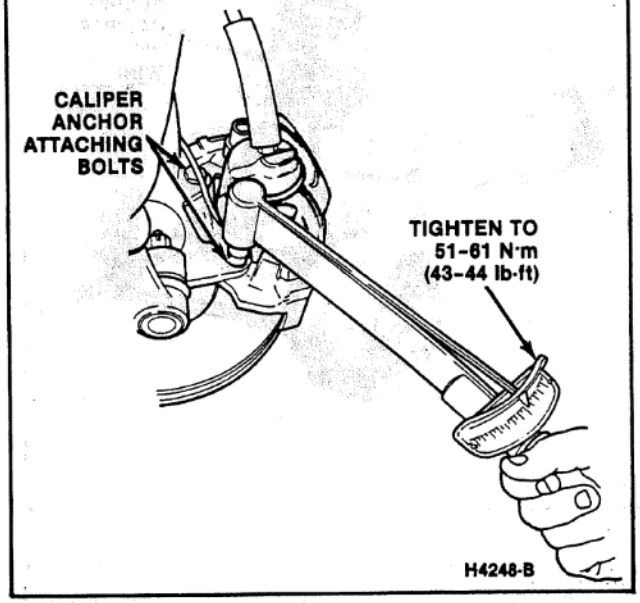
NOTE: The hub and rotor are a matched and balanced assembly. Before removing the rotor, locate the paint mark or etch mark that indicates proper hub-to-rotor alignment. If the marks are not present, mark the hub and rotor for assembly alignment. Failure to properly align the hub and rotor can result in an imbalance condition.

If the rotor has been removed without alignment marks, the rotor must be re-indexed. If necessary, refer to the procedure in this section.



Installation

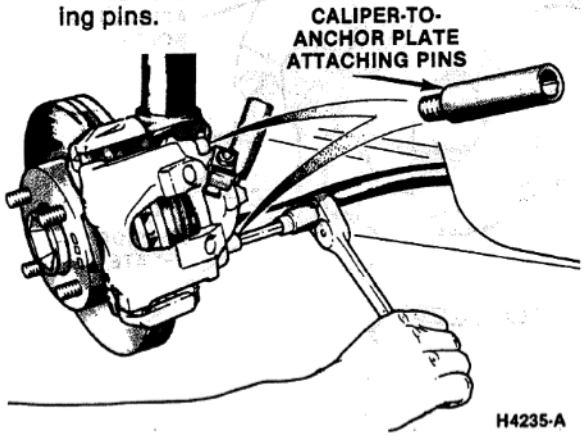
1. Install the rotor using the balance marks for alignment reference.
2. Position the caliper over the rotor and install the anchor plate-to-spindle carrier attaching bolts. Tighten the bolts to 51-61 N·m (43-44 lb. ft.).
3. Install the wheel.



CALIPER ANCHOR PLATE

Removal

1. Remove the wheel.
2. Remove the caliper-to-anchor plate attaching pins.

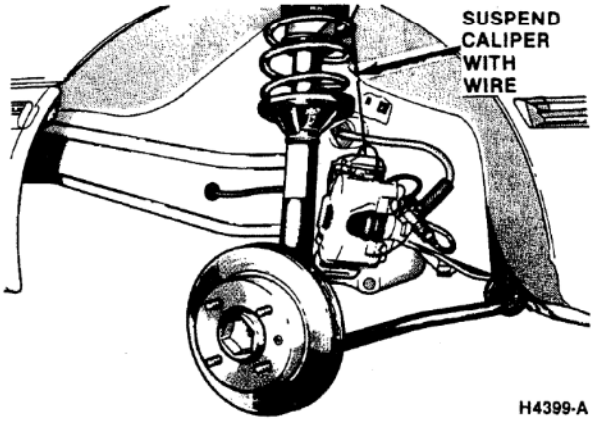


REMOVAL AND INSTALLATION

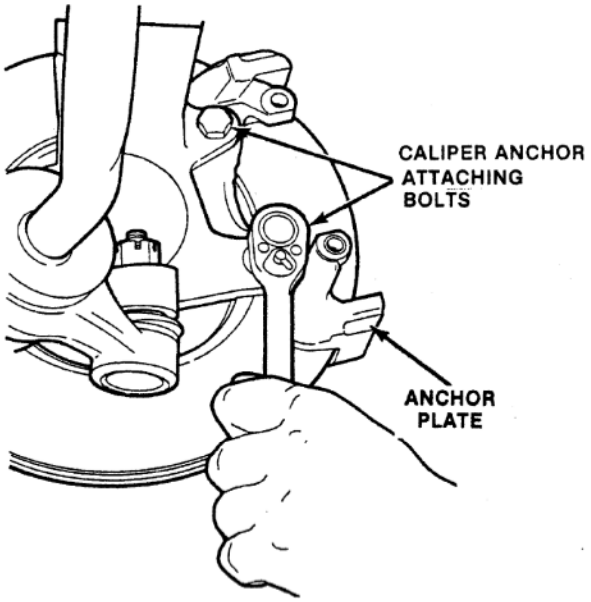
CALIPER ANCHOR

Removal (Continued)

3. Slide the caliper off the rotor. Suspend the caliper with wire.

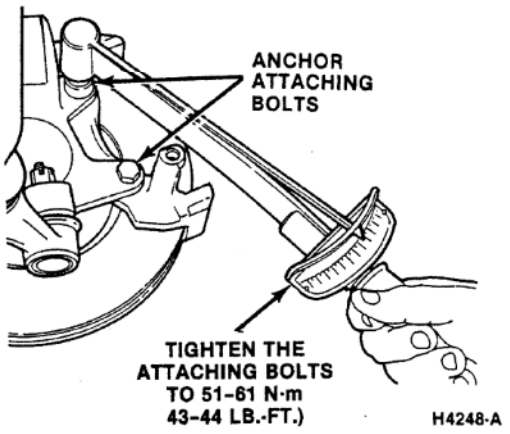


4. Remove the caliper anchor plate attaching bolts and the caliper anchor.

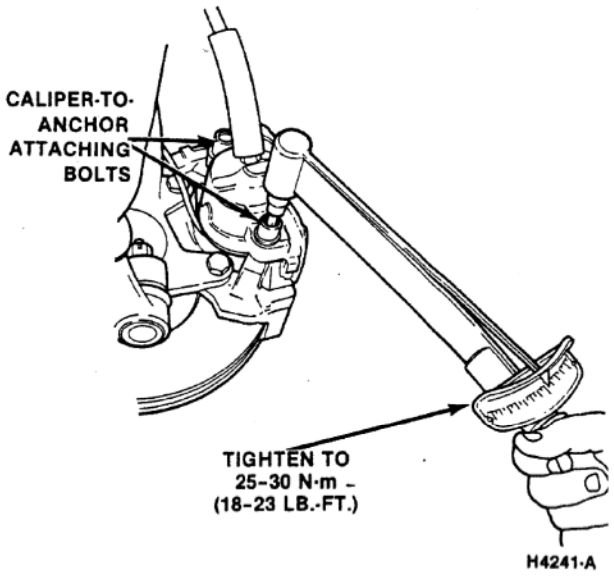


Installation

1. Position the anchor plate on the spindle carrier and install the anchor plate attaching bolts. Tighten the attaching bolts to 51-61 N·m (43-44 lb. ft.).



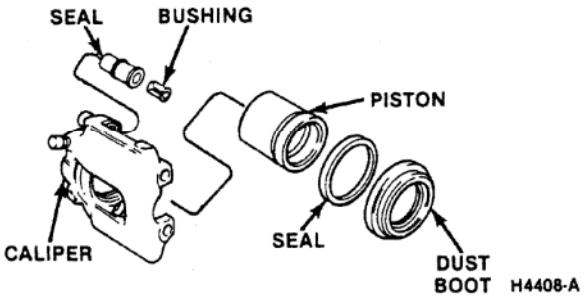
2. Position the caliper over the rotor and install the caliper-to-anchor plate attaching bolts. Tighten the attaching bolts to 25-30 N·m (18-23 lb. ft.).
3. Install the wheel.



DISASSEMBLY AND ASSEMBLY

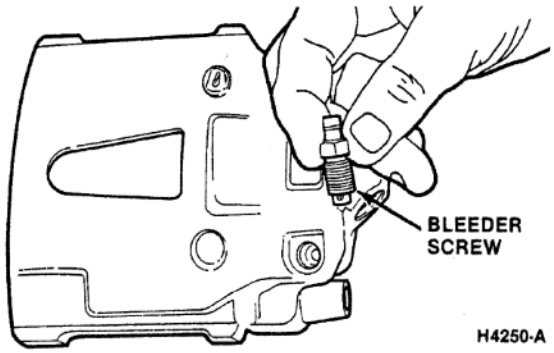
CALIPER

Disassembly



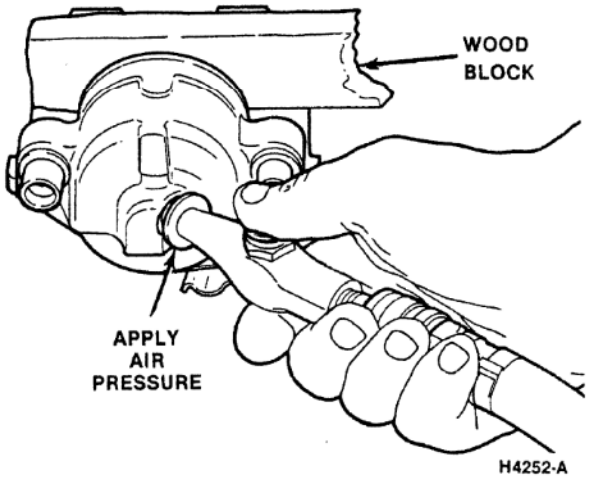
1. Remove the caliper assembly and the brake pads. If necessary, refer to the procedure in this section.

2. Open the bleeder screw and drain the brake fluid out of the caliper. Close the bleeder screw.



3. Position a block of wood or a roll of shop towels between the piston and the caliper.

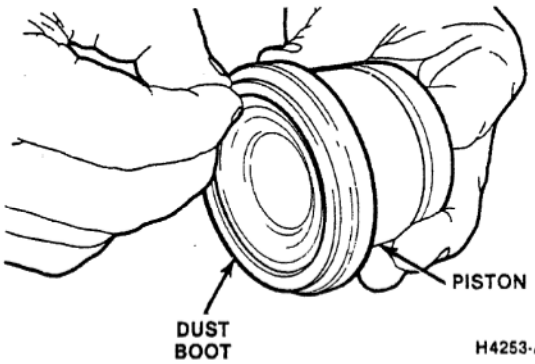
4. To remove the piston, apply air pressure through the fluid inlet port. Apply only enough air pressure to ease the piston out of the caliper.



WARNING: Do not use an excessive amount of air pressure to remove the piston. Excessive pressure can force the piston out with enough force to cause personal injury. Never attempt to catch the piston by hand as it comes out of the bore.

NOTE: An alternate procedure would be to use tools T73L-2196A Disc Brake Piston Remover and T50T-100-A Slide Hammer installed together on the caliper piston.

4. Remove the dust boot from the piston and discard.

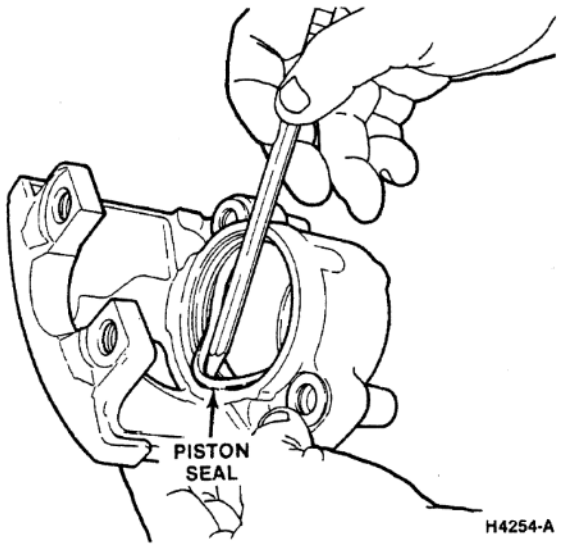


DISASSEMBLY AND ASSEMBLY

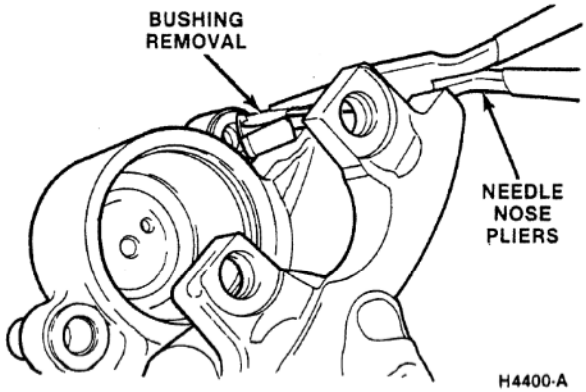
CALIPER

Disassembly (Continued)

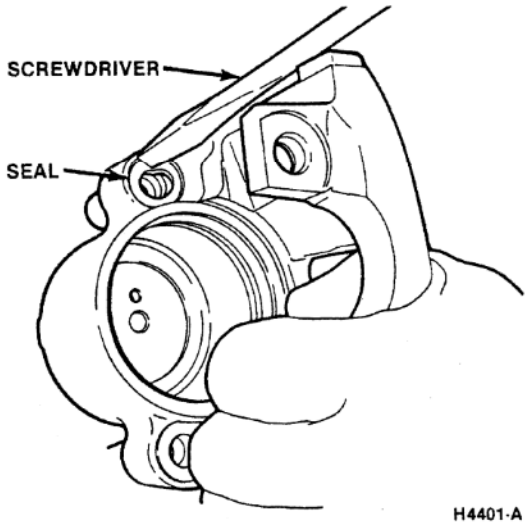
5. Remove the piston seal from the caliper and discard. Use a plastic stick or pencil to remove the seal. Do not use a screwdriver or other metal tool. A metal tool can scratch or nick the seal groove resulting in a possible seal leak.



6. Remove the caliper anchor pin bushing.



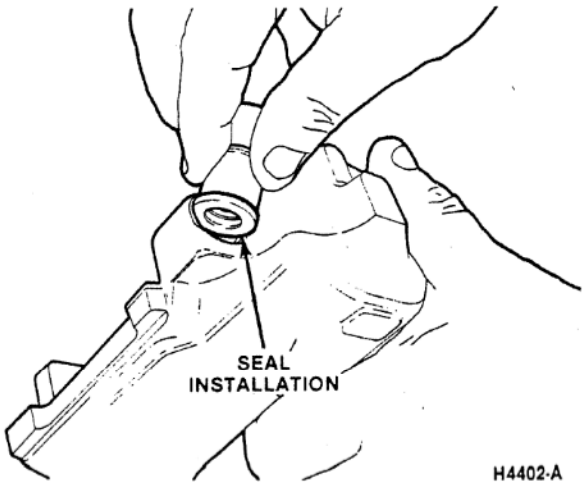
7. Remove the caliper anchor pin seal.



Assembly

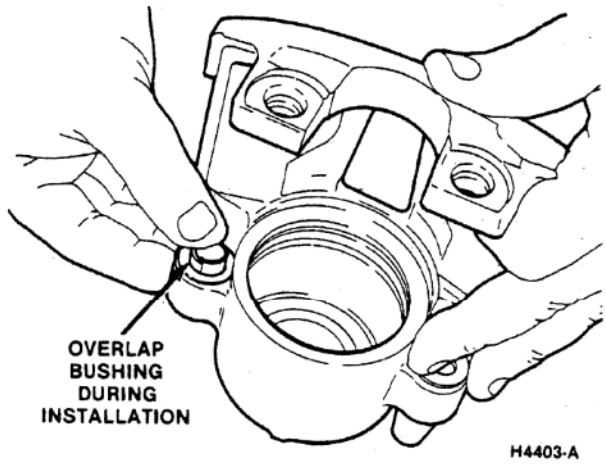
1. Install the caliper anchor pin seal.

   Spray the seal with silicone lubricant to aid installation.



DISASSEMBLY AND ASSEMBLY (Continued)

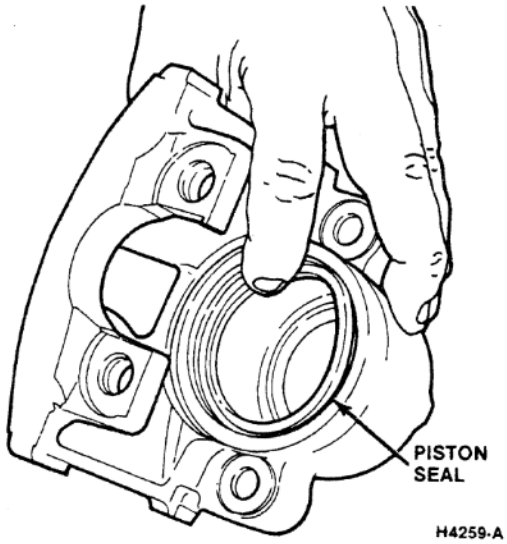
2. Install the caliper anchor pin bushing.



Overlap the edges of the bushing slightly to fit the bushing into the seal. After installation, press the bushing against the seal to remove the overlapping. When properly installed, the ends of the bushing must be butted against each other.

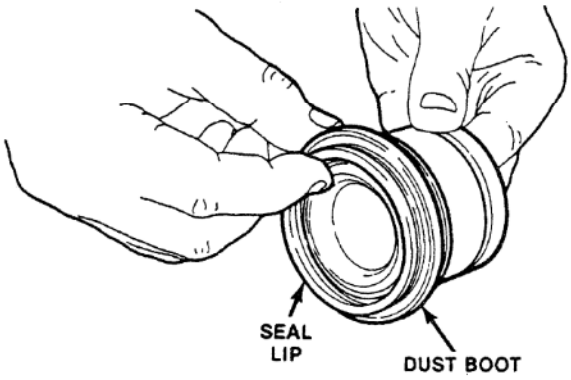
3. Lubricate a new piston seal with brake fluid and install in the seal groove.

Be sure the seal does not become twisted but is firmly seated in the groove.



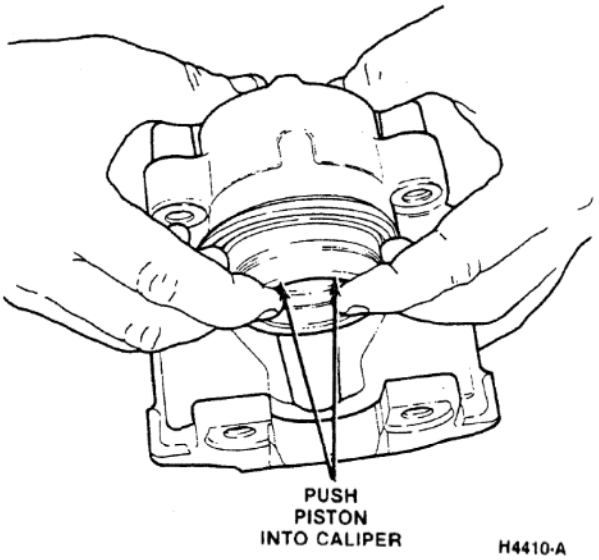
4. Install the dust boot on the piston.

Position the dust boot at the bottom of the piston. Hold the dust boot on the piston and pull on the seal lip until the seal unfolds, allowing the lip seal to extend beyond the bottom of the piston.



5. While holding the dust boot on the piston, fit the seal lip in the caliper bore and push the piston into the caliper.

As the piston enters the bore, the dust boot will re-fold to its original shape.



DISASSEMBLY AND ASSEMBLY (Continued)

COMPONENT INSPECTION CHART
BRAKE CALIPER

NOTE: Wash the caliper with clean denatured alcohol and dry with compressed air. Do not use petroleum-based solvents, kerosene, or gasoline to clean brake parts. Even a trace of mineral oil in a brake hydraulic system can cause damage to rubber parts.

COMPONENT	CHECK FOR
CALIPER	• Excessive corrosion or scoring in piston bore **NOTE:** Staining should not be confused with corrosion. Corrosion can be identified as pits or excessive roughness. • Nicked or damaged seal groove • Deep scratches **NOTE:** Light scratches or slightly corroded spots may be polished out with crocus cloth. Never use emery cloth or sandpaper. If scratches or corrosion are too deep to be polished out, replace the caliper. Do not hone the caliper bore. If the bore is scored or heavily pitted, the caliper must be replaced. • Cracked or broken casting • Nicked or damaged dust boot groove • Damaged, corroded or plugged bleeder screw
PISTON	• Cracks or other damage • Nicked or damaged dust boot groove • Scoring
ANTI-RATTLE SPRING	• Loss of tension • Bent or broken condition

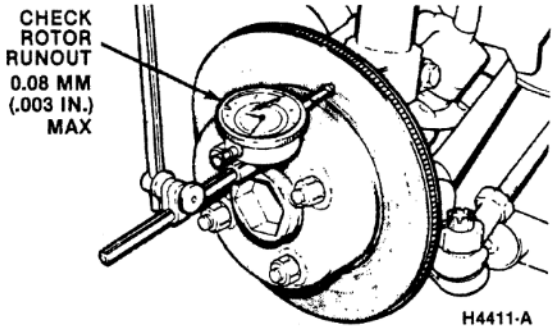
CH5231-B

GENERAL SERVICE PROCEDURES

ROTOR INDEXING

1. Install the rotor on the hub and install the wheel lug nuts.

2. Using a suitable dial indicator and holding fixture, measure the rotor runout. The indicator stylus should contact the rotor approximately 10 mm (7/16″) in from the edge.

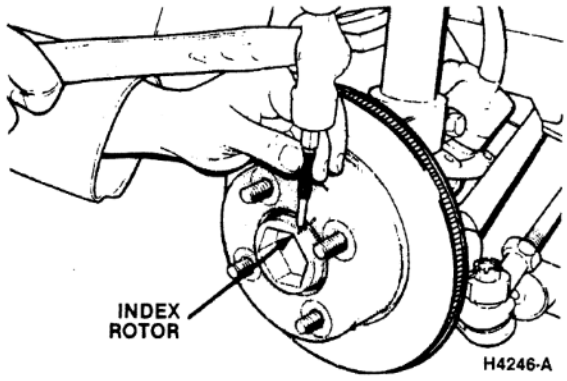


3. Rotate the hub and disc assembly and record the dial indicator reading.

- If the indicator reading is 0.08 mm (.003 in.) or less, the disc runout is within specifications and this position can be used during assembly.

- If the indicator reading is greater than 0.08 mm (.003 in.), the rotor should be repositioned on the hub in 90° increments until the lowest reading is obtained.
  If none of the four possible positions is within the runout specification, refer to Section 12-01 for further diagnosis.

4. Once a reading of 0.08 mm (.003 in.) is obtained, the alignment of the hub and rotor must be marked.

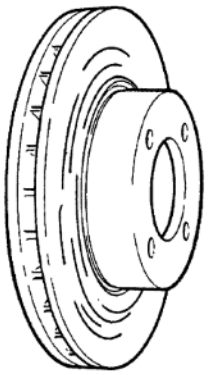
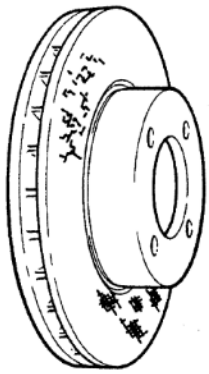


BRAKE ROTOR TROUBLESHOOTING CHART

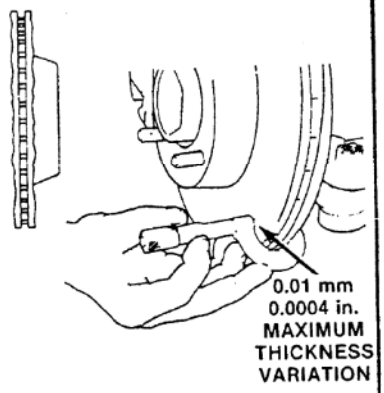
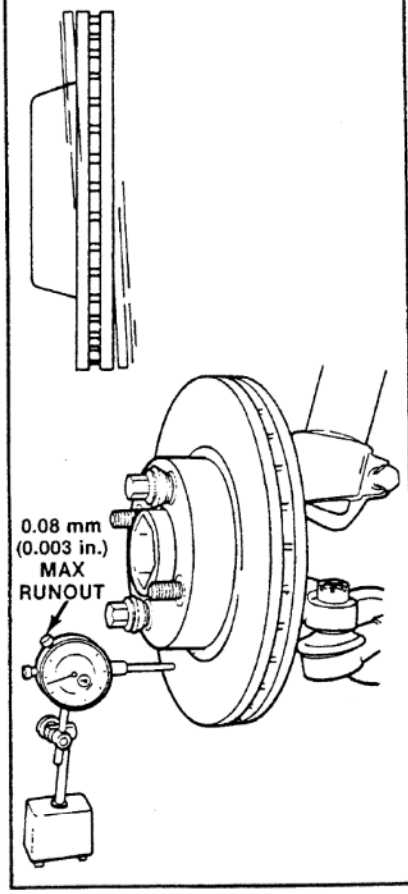
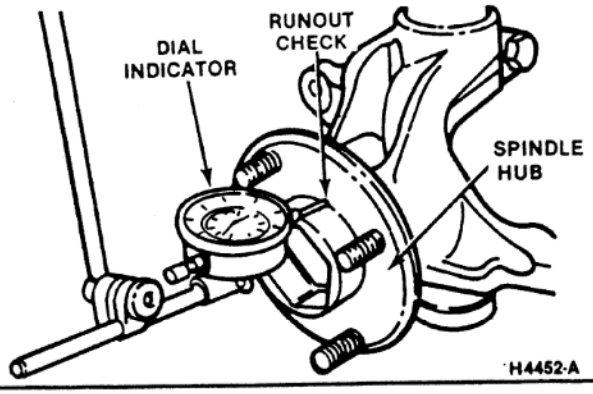
Unless the damage is obvious, a visual inspection of the rotor will not determine the required rotor service—resurface, recondition or replace. Tolerances on rotor thickness, parrallelism and run-out are very critical and must be measured with precision tools. Use the Brake Rotor Troubleshooting Chart as a guide for visual inspection and necessary measurements.

If the rotor braking surface is rusted or scaled, it must be cleaned before making any measurements.

NOTE: If the rotor braking surfaces are not scored or otherwise damaged, and all measurements are within tolerance, the rotor can be reused without further servicing.

CONDITION	CAUSE/CORRECTION
SCORING OR GROOVING 	Sand, grit, or any other hard or sharp particle contacting the rotor surface as it is rotating will cause scoring, which is visually detectable. Scoring that is .22 mm (.009 in.) or less will not affect brake performance. If the scores are deeper, recondition or replace the rotor.
BLUING OR HEAT CHECKING 	This condition results from excessive heat. Bluish, glassy spots on the surface of the rotor are actually places where the composition of the rotor has been changed from cast iron to steel. This condition may be accompanied by brake chatter, hard pedal (loss of friction), uneven braking action, or rapid brake pad wear. If the brake pad surface is charred, blued, or hardened with a heavy glaze, or if the rotor is severely heat checked, replace the rotor.

GENERAL SERVICE PROCEDURES (Continued)

CONDITION	CAUSE/CORRECTION
LACK OF PARALLELISM (THICKNESS VARIATION) 	This is excessive variation in rotor thickness. It causes a pulsating pedal, front end vibrations and, sometimes, "grab" during braking action. The symptoms are like those resulting from an out-of-round brake drum. Check parallelism with a micrometer. Measure the rotor at eight positions 45 degrees apart, about 15 mm (1/2-in.) in from the outside diameter. It is important to always check at a constant radius. The parallelism is the amount of variation between maximum and minimum measurements. Thickness variation should never be more than 0.01 mm (0.0004 in.). If the brake surface can be "trued" without going below minimum thickness, recondition the rotor.
EXCESSIVE LATERAL RUNOUT 	Lateral runout is the movement of the rotor from side to side (wobble) as it rotates. If the runout is excessive, it will knock the piston back into the cylinder bores creating excessive clearance between lining and rotor. On the next brake application, the pedal will go forward to the floor causing a pulsation and chatter. To check rotor lateral runout, install the rotor and secure with two wheel lug nuts. Mount a dial indicator so that the point of the stylus makes contact with the rotor surface about 10 mm (7/16-in.) from the rotor edge. Set the dial at zero. Slowly turn the rotor one complete turn while checking the reading. Lateral runout must not exceed 0.08 mm (0.003 in.). If runout exceeds specifications, remove the disc and measure the face runout of the spindle hub at its maximum diameter. If hub runout exceeds 0.06 mm (0.002 in.), replace the spindle. If necessary, refer to Section 11-16. If the hub runout is within specification, it may be possible to true up the rotor braking surface by refinishing. If necessary, refer to the procedure in this section. **Do not machine below the minimum thickness.** 

CH4269-A2

BRAKE MOTOR REFINISHING

General Information

Complete the inspection and measurement procedures outlined in the Brake Rotor Trouble-shooting Chart before refinishing a rotor. These checks and measurements will determine if the rotor should be resurfaced, reconditioned or replaced. Use the following definitions as a guideline:

RESURFACE with a flat sanding disc (with rotor turning) if scoring is light or if the rotor surface has severe rust scale.

RECONDITION if scoring is deep or if runout, thickness variation, flatness and parallelism are out of specification. Scoring of the brake rotor surfaces not exceeding 0.22mm (0.009 in.) in depth, which may result from normal use, is not detrimental to brake operation.

Treat both sides of the rotor in the same manner. If one side needs resurfacing, treat the opposite side in the same manner.

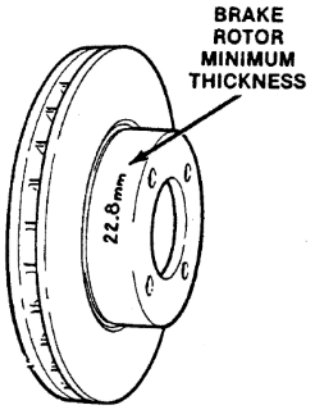
REPLACE if the rotor cannot be reconditioned to bring it within specifications and meet the minimum thickness specification after reconditioning.

Minimum Thickness

Brake rotor minimum thickness is shown on each rotor. This is the thickness at which the rotor becomes unsafe to use. It is called the discard thickness. To find the minimum thickness to which you can machine the rotor, add 0.762mm (0.030 in.) to the minimum thickness, 22.8mm (0.897 in.), (discard diameter) marked on the rotor. This 0.762mm (0.030 in.) allows for rotor wear after it has been resurfaced and returned to use.

If the thickness of the rotor is less than the minimum thickness, discard the rotor and install a new one.

Machining thinner than this limit could permit the rotor to wear past the safe discard point before the lining wears out. It may also result in severe overheating and fade because the thin rotor may be unable to absorb the heat generated during braking.



H4412-A

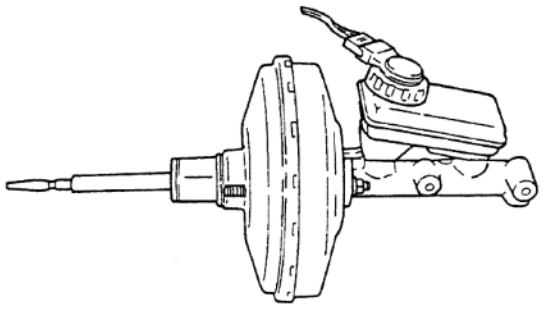
SECTION 12-50 Brake Booster

SUBJECT	PAGE
ADJUSTMENT	12-50-2
DESCRIPTION	12-50-1
REMOVAL AND INSTALLATION	
Brake Booster	12-50-3
REMOVAL AND INSTALLATION (Cont'd.)	
Vacuum Check Valve	12-50-6

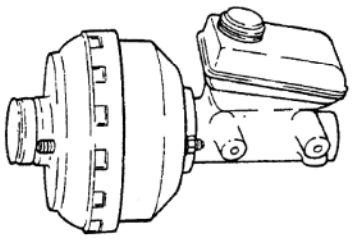
DESCRIPTION

NOTE: To increase the stopping power, the 1987 XR4Ti is equipped with a dual diaphragm brake booster. Operation of this booster is similar to the booster used in the 1985 and 1986 model XR4Ti.

The brake booster reduces the effort required to push the brake pedal and apply the brakes. The reduction occurs due to pressure differential within the brake booster. Engine vacuum is present on both sides of the diaphragm when the engine is running. When the brake pedal is pressed, the input rod assembly moves forward inside the valve body until the vacuum port closes; at this point vacuum is still present on each side of the diaphragm. As the input rod assembly continues to move forward, an atmospheric port is opened and atmospheric pressure enters the rear half of the brake booster and assists the input rod in pushing the diaphragm plate forward and the output rod pushes against the master cylinder piston.



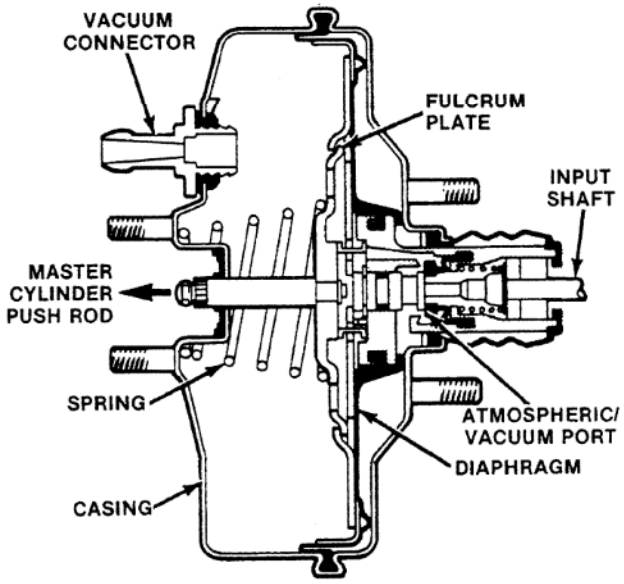
1985 & 1986



1987 H4294-A

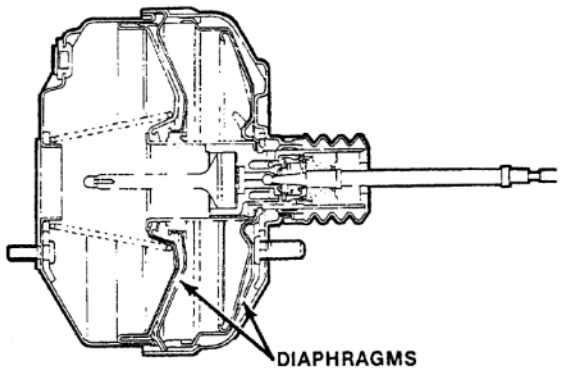
DESCRIPTION (Continued)

When the brake pedal is held in this position, the diaphragm will momentarily continue to move forward and so compress the outer edges of the reaction disc. This movement causes the center of the disc to press back the input rod and thus closes the atmospheric port. Further movement of the brake pedal either opens the vacuum port or the atmospheric port, depending on whether the brake pedal is released or depressed further.



1985 & 1986

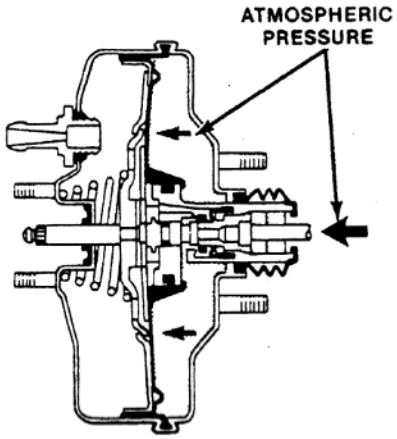
The vacuum connection contains a check valve which closes when the engine is shut off. The closed valve traps engine vacuum in the booster. This reserved vacuum allows several assisted brake applications with the engine off.



1987

H4378-A

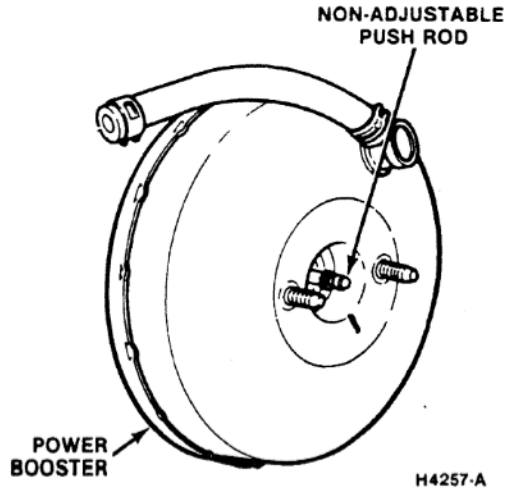
When the brake pedal is released, the vacuum port is opened and the atmospheric pressure in the rear chamber is drawn into the front chamber of the brake booster and from there to the intake manifold. The atmospheric port remains closed while the input rod assembly returns to its original position, assisted by the diaphragm return spring. The diaphragm is then again suspended in vacuum until the next brake application.



H5274

ADJUSTMENT

The brake booster push rod length is preset during production and is not adjustable.



H4257-A

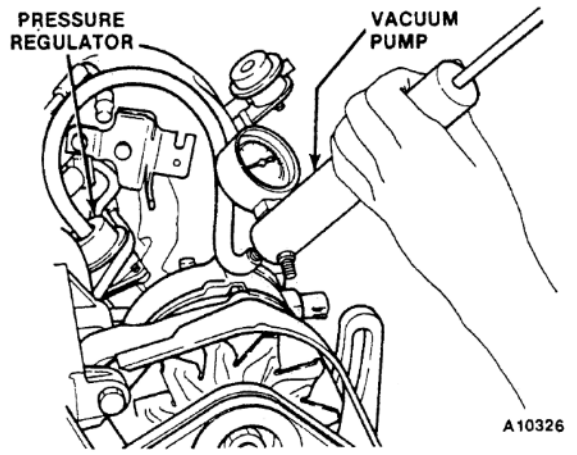
REMOVAL AND INSTALLATION

Brake Booster

Removal

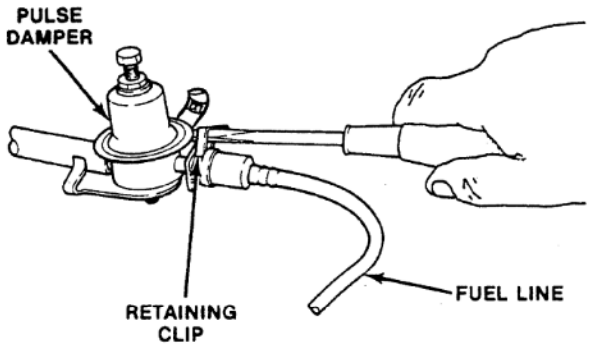
1. Press the brake pedal several times to deplete the vacuum reserve in the power booster.
2. Depressurize the EFI fuel system using a hand operated vacuum pump. Connect the pump hose to the fuel system pressure regulator and apply at least 25 inches of vacuum.

NOTE: It takes at least three minutes for the fuel system to depressurize. If necessary, refer to the Fuel System Pressure Relief Procedure in Section 24-50.

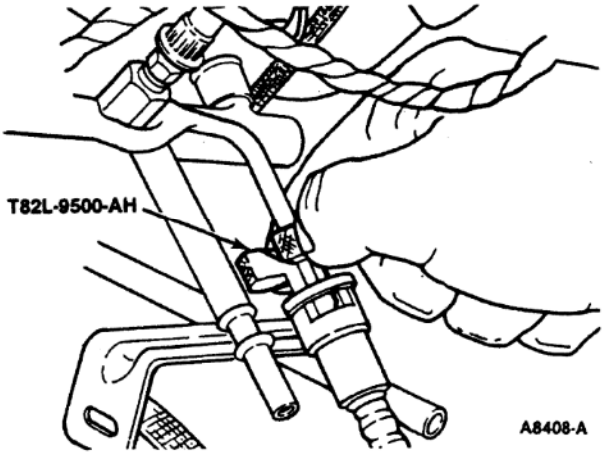


CAUTION: Fuel supply lines will remain pressurized for some period of time after the engine is shut off. System pressure must be relieved before disconnecting any fuel lines.

3. Disconnect the fuel inlet line at the pulse damper.

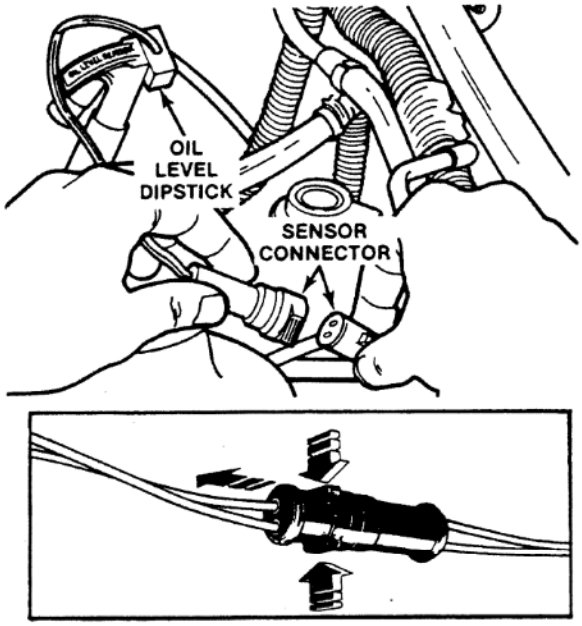


4. Disconnect the fuel return line using Quick Connect Removal Tool T82L-9500-AH.



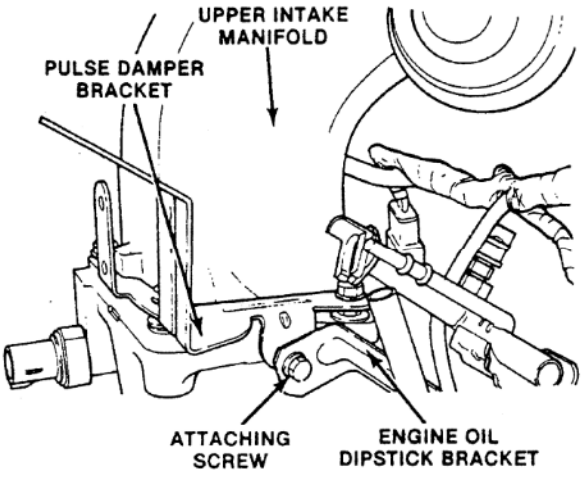
5. Disconnect the low oil level sensor connector and remove the engine oil level dipstick.

NOTE: Electrical connector at oil dipstick applies to 1986 and earlier models.

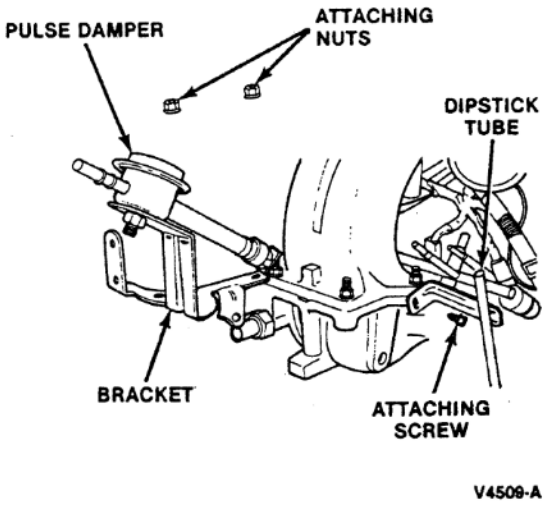


REMOVAL AND INSTALLATION (Continued)

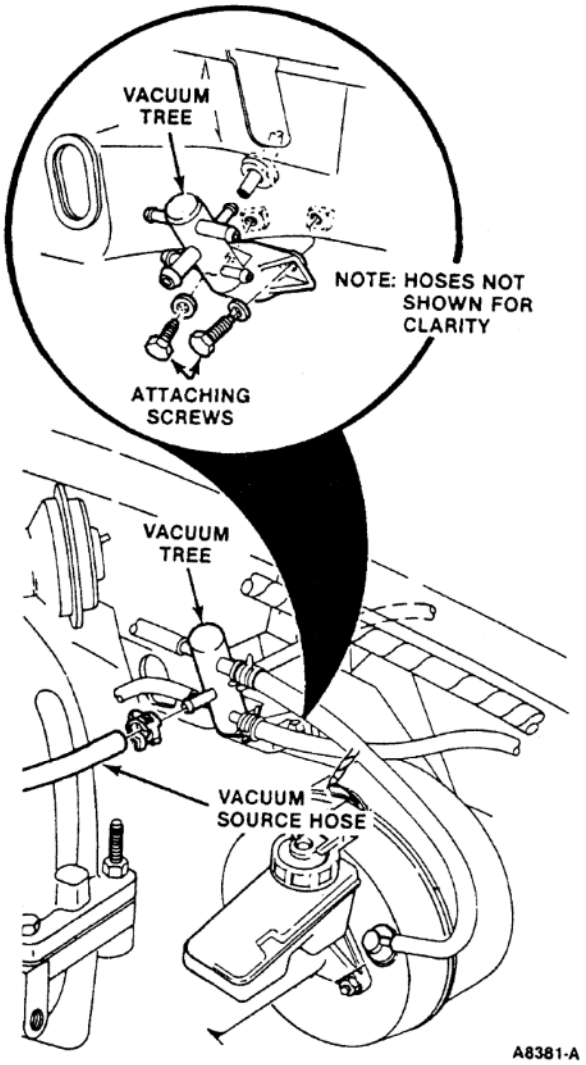
6. Remove the screw attaching the engine oil dipstick tube to the pulse damper bracket.



7. Remove the stud nuts attaching the pulse damper bracket to the intake manifold.
8. Disconnect the pulse damper from the fuel manifold and remove the damper/bracket assembly.



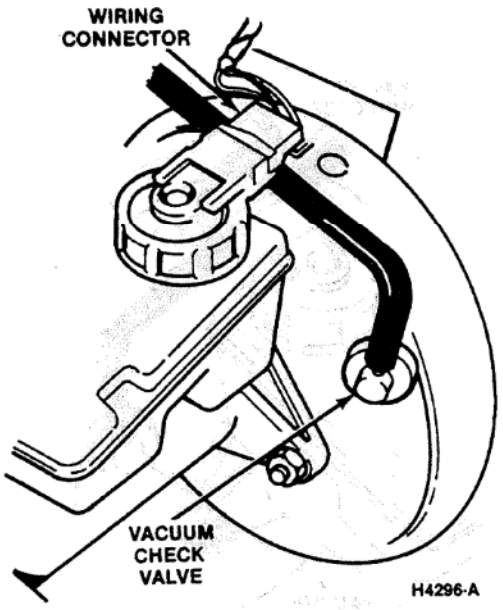
9. Disconnect the source hose from the vacuum "tree" and remove the vacuum tree attaching screws.



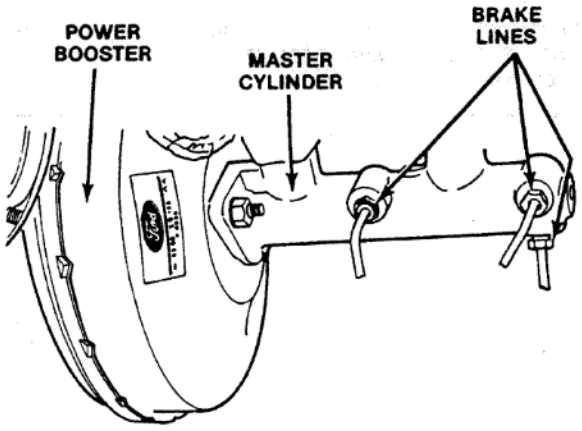
10. Disconnect the low brake fluid warning wiring connector from the master cylinder cap.

REMOVAL AND INSTALLATION (Continued)

11. Pull the vacuum check valve (or elbow) out of the power booster.

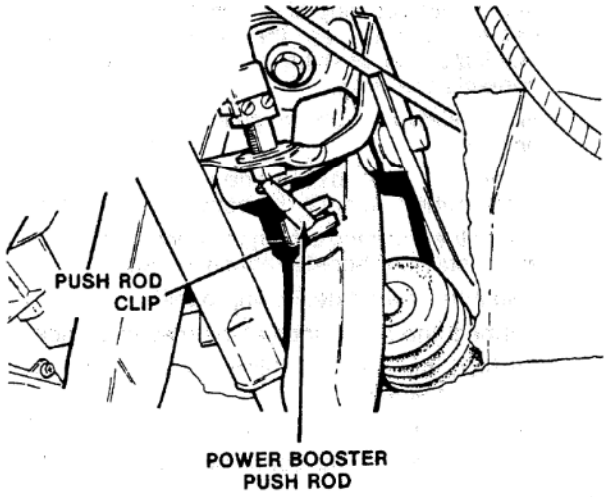


12. Disconnect the brake lines at the master cylinder.

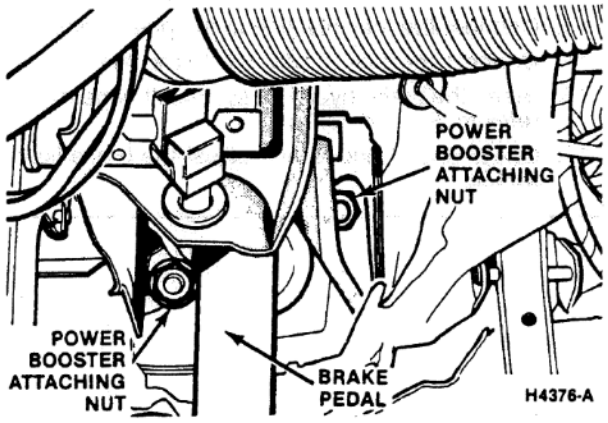


Plug the brake tubes to prevent the entry of contamination.

13. Inside the vehicle, remove the sound deadening panel located under the instrument panel.
14. Remove the booster push rod to brake pedal retaining clip.



15. Remove the booster attaching nuts (2).



16. Remove the power booster. Use care to prevent damage to any underhood painted surfaces such as the suspension strut tower. If necessary, tape shop cloths over these areas to prevent damage.

If necessary, the master cylinder can be removed from the brake booster by removing the two attaching nuts. After installing the master cylinder, tighten the attaching nuts to 21 to 27 N·m (16 to 20 lb-ft).

REMOVAL AND INSTALLATION (Continued)

Installation

1. Apply a bead of caulking cord D6AZ-19560-A, or equivalent, to the rear of the booster where it mates to the dash panel.
2. Make sure the pedal bushing is on the booster push rod and position the booster in the vehicle.

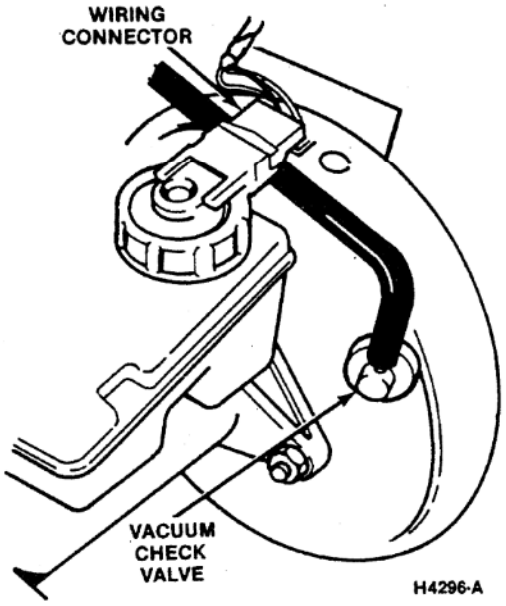
   Apply a light coating of lubricant on the bushing before installing on the booster push rod. Lubricate the bushing at the point where it contacts the pedal.
3. From inside the vehicle, guide the booster into position.

   A helper may be needed in the engine compartment to push the booster into position.
4. Install the retaining clip on the booster push rod and install the booster attaching nuts.
5. Install the sound deadening panel.
6. Connect the brake lines at the master cylinder.
7. Position the vacuum "tree" and install the attaching screw.
8. Connect the source hose to the vacuum "tree."
9. Connect the wiring connector at the master cylinder cap.
10. Connect the pulse damper to the fuel rail and position the bracket on the intake manifold studs.
11. Install the pulse damper bracket stud nuts.
12. Install the engine oil dipstick tube bracket attaching screw.
13. Install the engine oil level dipstick and connect the low oil level sensor connector.
14. Connect the fuel inlet line to the pulse damper.
15. Connect the fuel supply line to the fuel rail.
16. Bleed the brake hydraulic system. If necessary, refer to Section 12-50.
17. Check and, if necessary, adjust the brake light switch.

Vacuum Check Valve

Removal

Pull the check valve out of the brake booster grommet and remove from the vacuum hose.



Installation

Lubricate the vacuum hose and brake booster grommet with silicone spray. Install the valve in the hose and push it into place in the brake booster grommet.

NOTE: On 1987 models the vacuum check valve is part of the vacuum hose assembly and is not replaceable as a single item.

SECTION 12-70 Parking Brake

SUBJECT	PAGE
ADJUSTMENTS	
Parking Brake Cable Adjustment	12-70-2
DESCRIPTION	12-70-1

SUBJECT	PAGE
REMOVAL AND INSTALLATION	
Parking Brake Cable	12-70-3
Parking Brake Lever	12-70-7

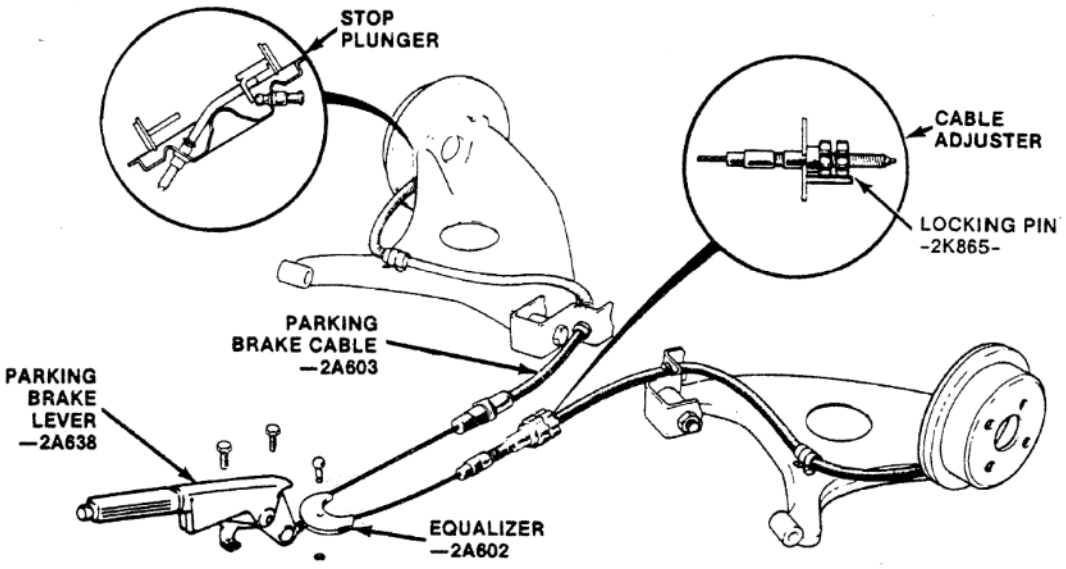
DESCRIPTION

The parking brake is a mechanical, rather than hydraulic, method of applying the rear brakes. Normally, the parking brakes are used whenever the vehicle is parked as a back-up system to prevent unexpected vehicle movement.

The parking brakes on the XR4Ti are applied when a hand lever located in the console is pulled upward by the driver. The lever motion is transferred to the rear brake shoes through a cable. A second lever connects the cable to the secondary brake shoes.

When the parking brake is applied, the cable pulls the brake shoe levers which force the secondary shoes outward against the brake drum.

Movement of the secondary shoe is transferred to the primary shoe by the parking brake strut. As the secondary shoe contacts the brake drum, the strut pushes the primary shoe against the drum. Both sets of rear brake shoes are now applied against the rear brake drums.



DESCRIPTION (Continued)

The hand lever is held up in the applied position by a locking pawl and quadrant. A button on the end of the hand lever is pressed to disengage the pawl from the quadrant teeth and release the parking brake. As the lever is lowered to the released position, cable tension is relaxed and the brake shoe return springs pull the shoes away from the drum.

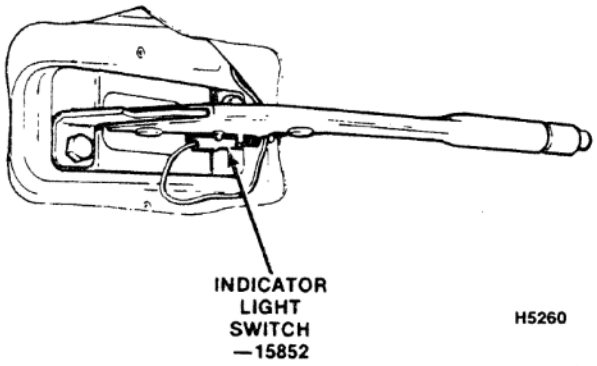
Parking brake stop plungers are installed in both rear brake backing plates. These plungers will be used to determine correct parking brake cable adjustments.

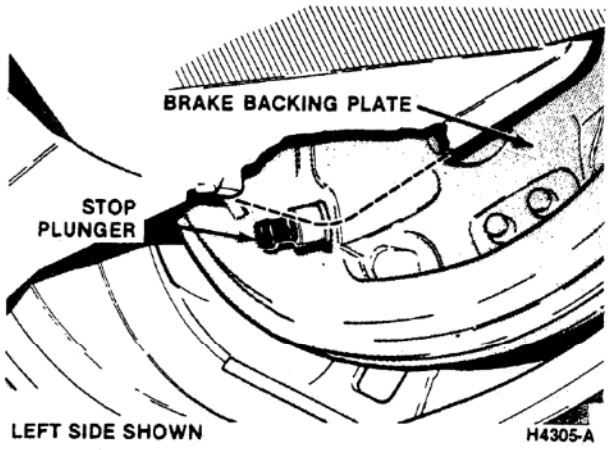
An indicator light in the instrument panel comes on whenever the parking brake is applied and the ignition key is ON. The light remains on until the parking brake hand lever is moved to the released position. The light circuit is completed by a small ground switch attached to the parking brake lever frame. When the lever is pulled upward to apply the brakes, a tab on the handle releases a spring-loaded switch plunger and closes the ground circuit. When the lever is released, the spring releases the switch contacts and the ground circuit opens.

The indicator light serves a second function. If the light is on with the parking brake released, the driver is alerted to a problem in the brake hydraulic system.

On vehicles built after September 1985 (build code FC) a locking pin is added to the parking brake cable adjustment bracket to prevent the adjuster locknuts from turning. A new pin must be installed when the parking brake cable is adjusted or replaced.

CAUTION: Any affected vehicle on which the locking pin is missing must have the parking brake adjustment set to specification and a new locking pin installed.



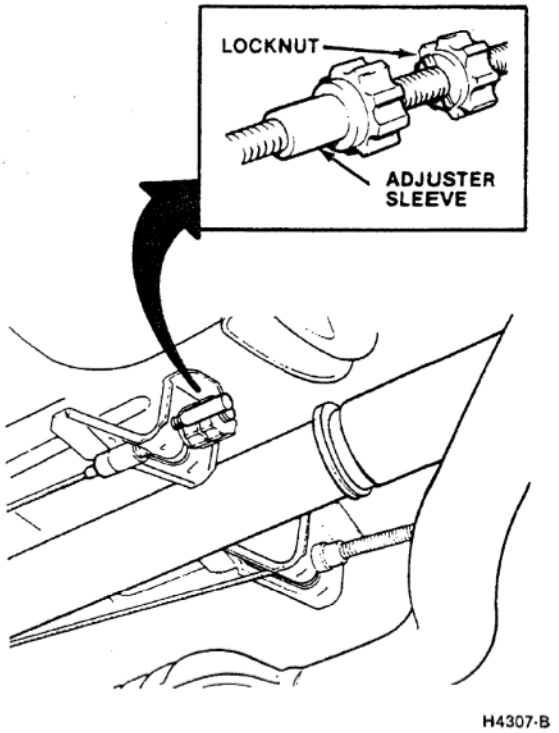


ADJUSTMENTS

Parking Brake Cable Adjustment

NOTE: Parking brake stop plungers are installed in both rear brake backing plates. These plungers will be used to determine correct parking brake cable adjustments.

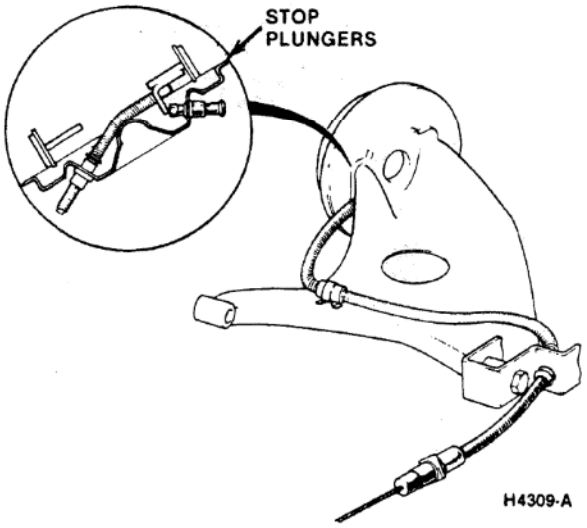
1. Be sure the parking brake hand lever is in the released position.
2. Pump the brake pedal to be sure the brake lining self-adjuster is properly set.
3. Raise the vehicle.
4. Remove nylon locking pin, if equipped.
5. Loosen the adjuster locknut and rotate adjuster sleeve along the cable casing until in-and-out movement can be felt at both parking brake stop plungers.



ADJUSTMENTS (Continued)

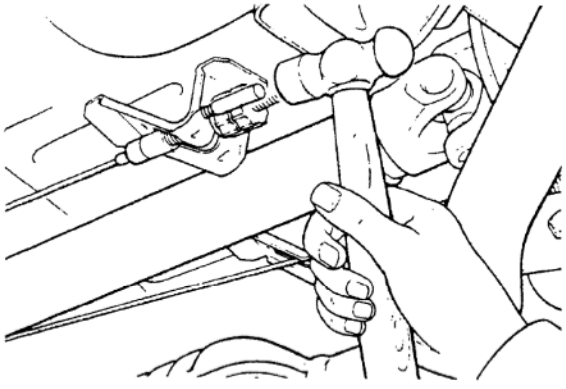
NOTE: Both the adjuster and locknut are threaded onto the cable casing. Any attempt to pry them apart will result in damage to the sleeve and/or locknut. To loosen the locknut, hold the adjuster with pliers and turn the locknut counterclockwise with another set of pliers.

6. Tighten the adjuster against the retaining bracket until a slight movement is felt at each stop plunger.



NOTE: When added together, the total movement of the plungers should not exceed 4.0mm (0.16 in.)—a very slight movement.

7. Tighten the locknut by hand against the sleeve as much as possible.
8. Tighten the locknut an additional two "clicks" using suitable pliers.
9. Turn the rear wheels by hand to be sure the brake linings are not dragging against the drum.
10. Install a new nylon locking pin by tapping it into place.



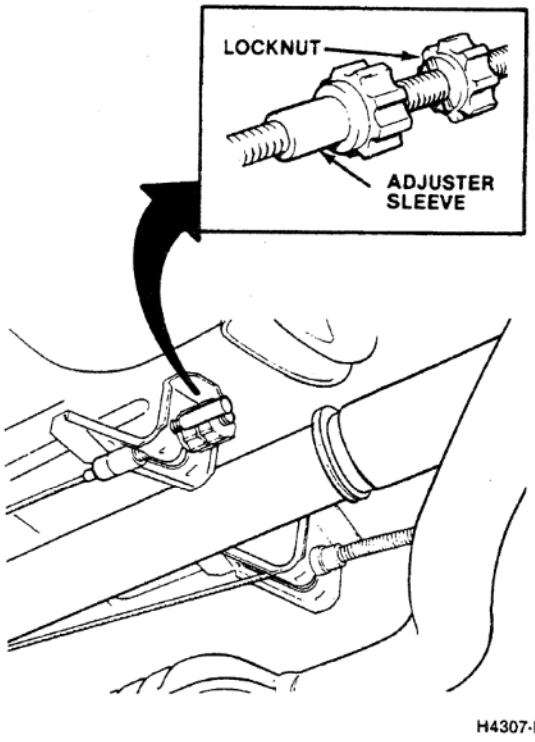
REMOVAL AND INSTALLATION

Parking Brake Cable

Removal

1. Raise the vehicle.
2. Remove the locking pin (if equipped) and loosen the parking brake cable adjuster locknut.

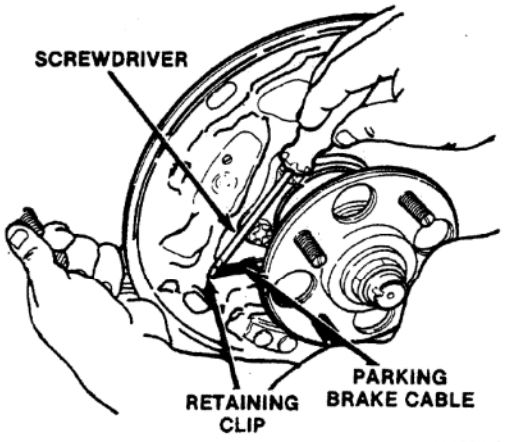
NOTE: Both the adjuster sleeve and locknut are threaded onto the cable casing. Any attempt to pry them apart will result in damage to the sleeve and/or locknut. To loosen the locknut, hold the sleeve with pliers and turn the locknut counterclockwise with another set of pliers.



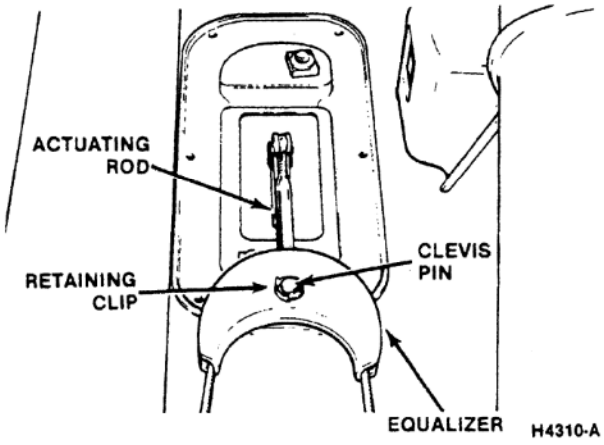
3. Remove the brake shoes on both sides of the vehicle. If necessary, refer to Section 12-02.

REMOVAL AND INSTALLATION (Continued)

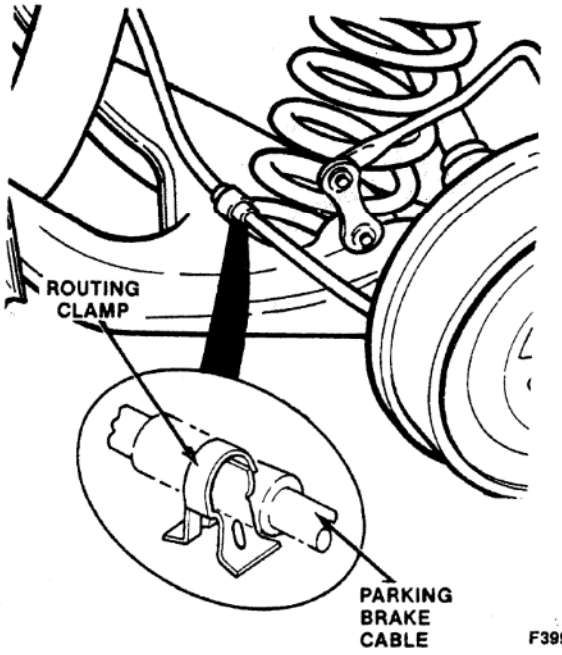
4. Using a screwdriver, spread the retaining clip and pull the cable out of the backing plate.



5. Remove the clip and clevis pin attaching the cable equalizer to the parking brake lever rod.



6. Using a screwdriver, open the routing clamps and disengage the cable from both control arms.

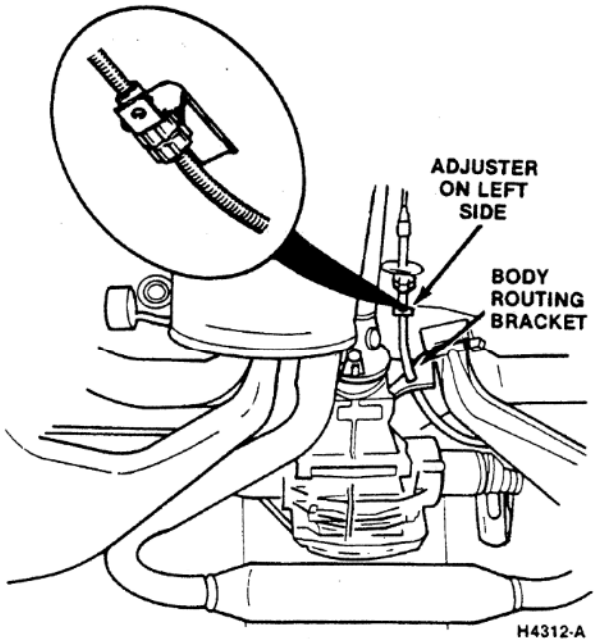


7. Thread the cable through the body brackets and remove from the vehicle.

REMOVAL AND INSTALLATION (Continued)

Installation

1. Position the cable through the body brackets. Make sure the cable adjuster is on the left side of the vehicle.
2. Pull the cable ends through the backing plates. Make sure the retaining clip engages the cable retaining groove.
3. Position the parking brake cable equalizer. Install the clevis pin and retaining clip.
4. Position the cable in the lower control arm routing clamps. Secure the clamps around the cable casing.
5. Install the brake shoes. If necessary, refer to Section 12-02.
6. Adjust the parking brake cable and install a new locking pin. If necessary, refer to the procedure in this Section.



REMOVAL AND INSTALLATION (Continued)

COMPONENT INSPECTION CHART
PARKING BRAKE CABLE

COMPONENT	CHECK FOR
BACKING PLATE	• Missing or damaged parking brake stop plunger — Check the nylon retainer for damage. • Broken, bent or otherwise damaged parking brake retaining clip
BRAKE SHOE LEVER	• Loose lever attaching pin — The pin should be securely riveted to the brake shoe lever, but the lever should rotate freely on the pin. If any binding occurs, clean and lubricate the pin and lever assembly. • Bent or twisted lever
PARKING BRAKE STRUT	• Bends or other distortion • Elongated or damaged lever slot • Spread or distorted strut return spring
ROUTING BRACKETS	• Broken or missing lower control arm clamps • Bent, missing or loose body brackets • Missing or damaged locking pin
EQUALIZER	• Worn cable guide • Damaged or worn clevis pin • Bent or broken pin retaining clip • Worn lever rod eye

CH4311-B

REMOVAL AND INSTALLATION (Continued)

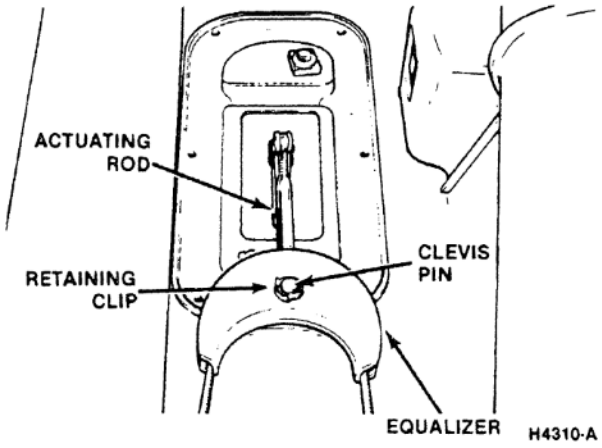
Parking Brake Lever

Removal

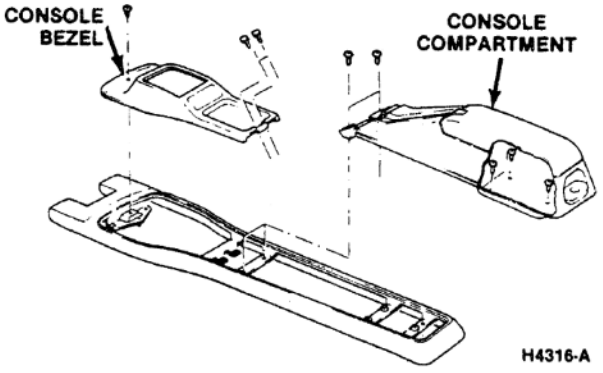
1. Raise the vehicle
2. Remove the locking pin (if equipped) and loosen the parking brake cable adjuster locknut.

NOTE: Both the adjuster sleeve and locknut are threaded onto the cable casing. Any attempt to pry them apart will result in damage to the sleeve and/or locknut. To loosen the locknut, hold the sleeve with pliers and turn the locknut counterclockwise with another set of pliers. If necessary, refer to the Parking Brake Adjustment Procedure in this Section.

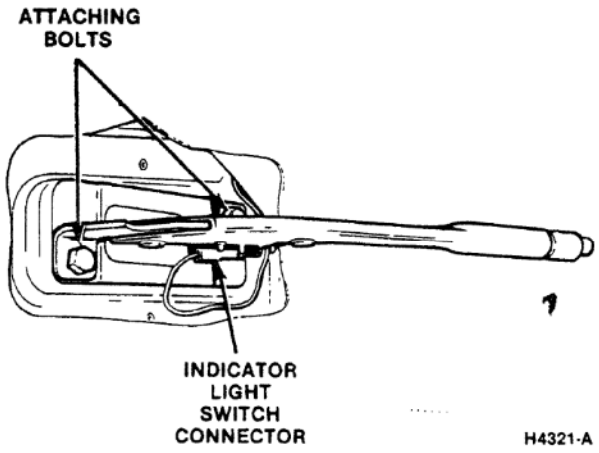
3. Remove the clip and clevis pin attaching the cable equalizer to the lever rod.



4. Remove the console bezel and console compartment. If necessary, refer to Section 45-31.



5. Remove the parking brake lever attaching bolts.



6. Disconnect the wire from the parking brake indicator light switch and remove the lever.

Installation

1. Be sure the parking brake rod dust boot is seated in the floor pan, and position the parking brake lever and install the attaching bolts.
2. Connect the indicator light switch wire and install the lever attaching bolts.
3. Install the console compartment and bezel. If necessary, refer to Section 45-31.
4. Raise the vehicle.
5. Position the parking brake cable equalizer. Install the clevis pin and retaining clip.
6. Adjust the parking brake cable and install a new locking pin. If necessary, refer to the procedure in this Section.

SECTION 12-80 BRAKE HYDRAULIC SYSTEM

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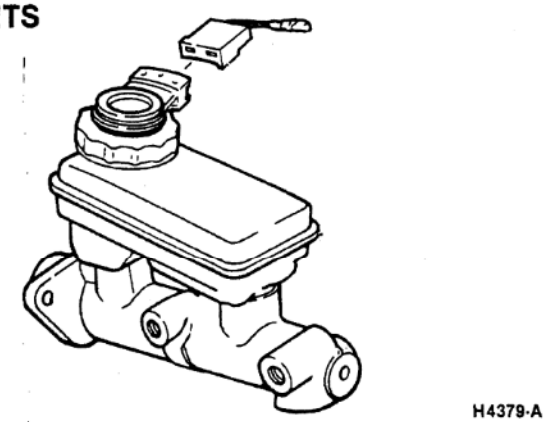
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Pressure Control Valve 4
Brake Pedal 4
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DISASSEMBLY AND ASSEMBLY

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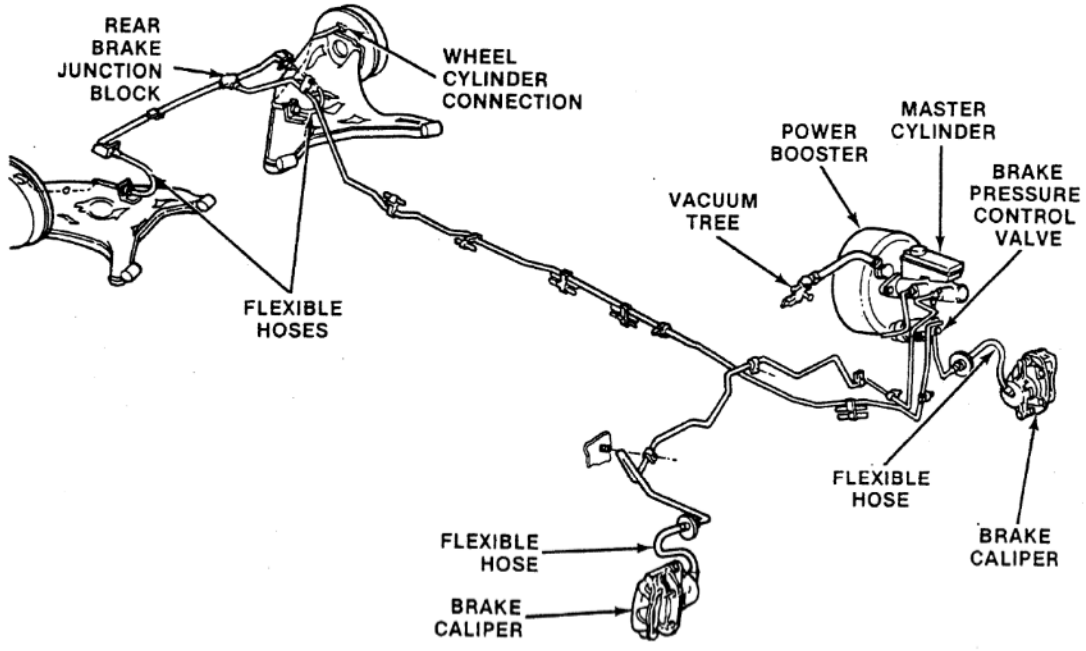
Hydraulic System Flushing 10
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H4379-A

DESCRIPTION

The brake hydraulic system is a front-to-rear split system with a dual piston master cylinder. Double-wrapped steel tubing extends from the master cylinder pressure fittings to the rear wheel cylinders and front calipers. Flexible hoses make the final connection between the body-mounted brake tubes and the suspension-mounted brake assemblies.

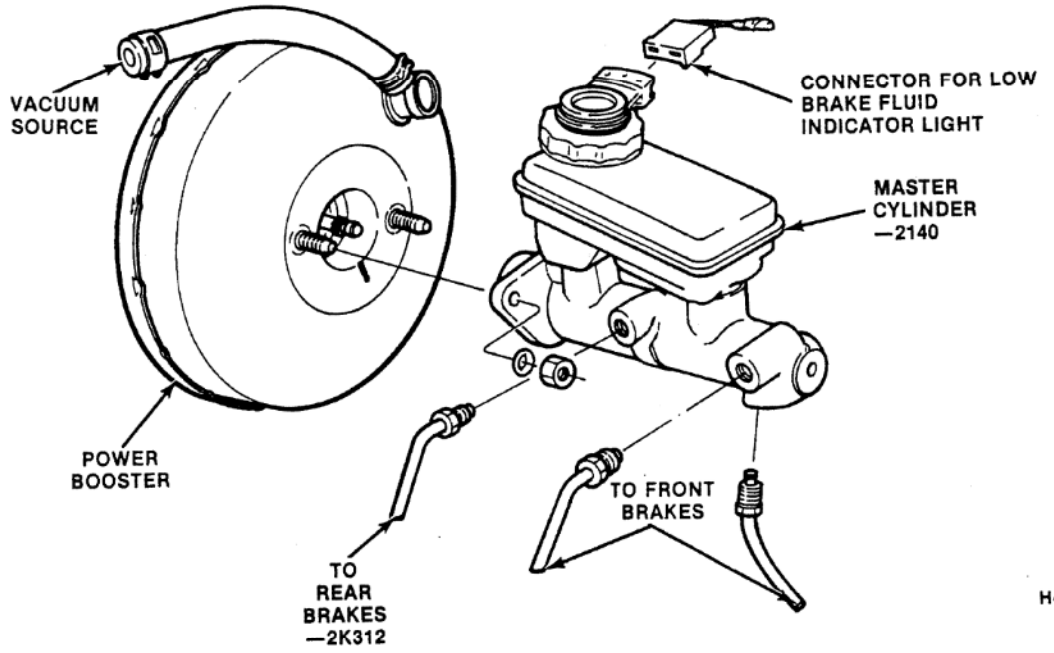


H4385-A

DESCRIPTION

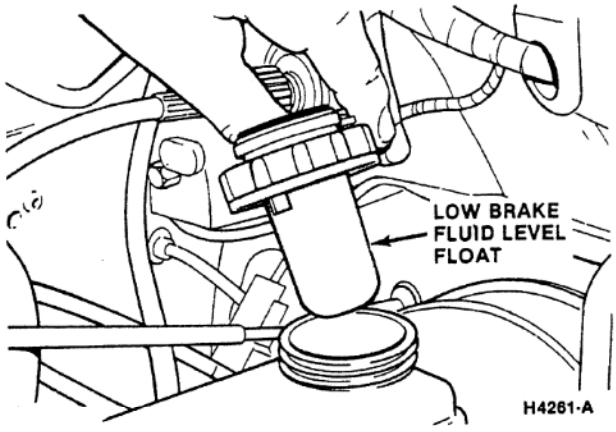
MASTER CYLINDER

The master cylinder is mounted on the power booster and is the source of hydraulic system pressure. A nylon-molded reservoir is mounted on top of the master cylinder body. The reservoir is held in position by rubber grommets that also serve as seals between the master cylinder body and reservoir tubes.



LOW FLUID LEVEL INDICATOR

If the fluid level in the master cylinder drops below a specified level, the driver is alerted to the situation through the low brake fluid level indicator light. The light is located in the instrument cluster and comes on when the float in the master cylinder completes the indicator light circuit. The brake indicator light serves a dual function. It serves as the low brake fluid level indicator light and as the parking brake applied indicator light.

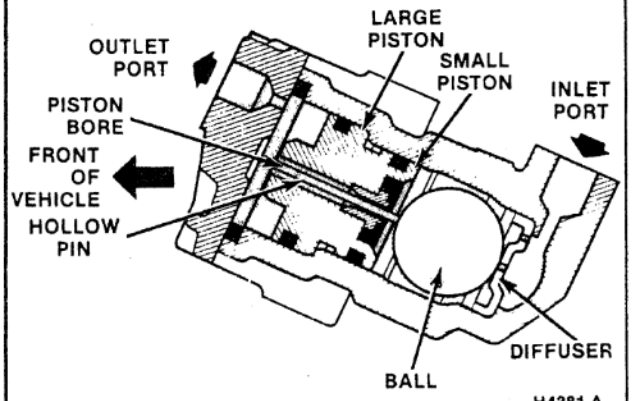


DESCRIPTION

BRAKE PRESSURE CONTROL VALVE

Front-to-rear braking action is balanced by a brake pressure control valve installed in series with the master cylinder and rear wheel cylinders. The valve is installed in the engine compartment just below the master cylinder. The installation angle is critical because the deceleration rate will determine the effectiveness of the valve in controlling rear brake pressure.

Under heavy braking, the front of the vehicle will drop due to weight transfer. As the vehicle "noses" down, the change in body angle causes a ball weight within the valve to roll forward. As the ball changes position, its position and valves will regulate pressure from the master cylinder to the rear brakes. The controlled brake pressure prevents rear wheel lockup and skidding regardless of vehicle load. In conditions where there may be a risk of skidding, vehicle stability is increased and stopping distance reduced.



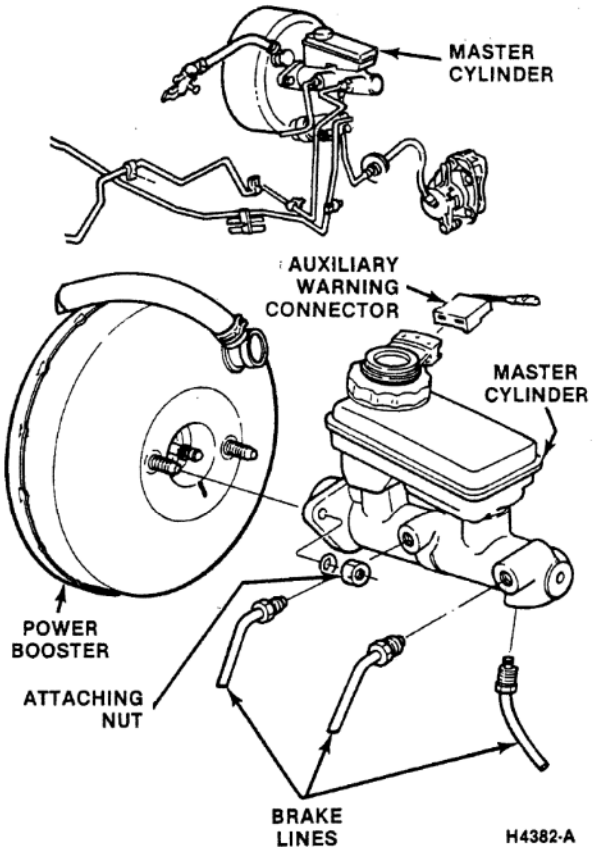
REMOVAL AND INSTALLATION

MASTER CYLINDER

Removal

1. Disconnect the low fluid level sensor wiring.
2. Disconnect the brake lines from the master cylinder.

   Cap the lines and master cylinder ports.
3. Remove the attaching nuts and the master cylinder.



Installation

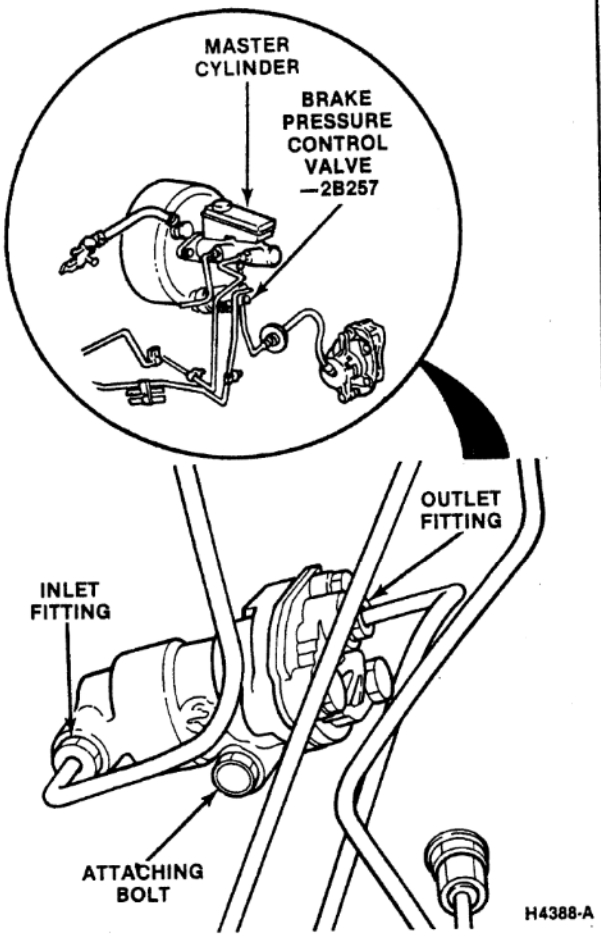
1. Position the master cylinder and install the attaching nuts. Tighten the attaching nuts to 21 to 27 N·m (16 to 20 lb-ft).
2. Connect the brake lines to the master cylinder.
3. Connect the low fluid level sensor wiring.
4. Fill the master cylinder to the proper level and bleed the front and rear hydraulic systems. If necessary, refer to the procedure in this section.

REMOVAL AND INSTALLATION

PRESSURE CONTROL VALVE

Removal

1. Raise the vehicle.
2. Disconnect the brake lines from the pressure control valve.
3. Remove the attaching bolt and the pressure control valve.



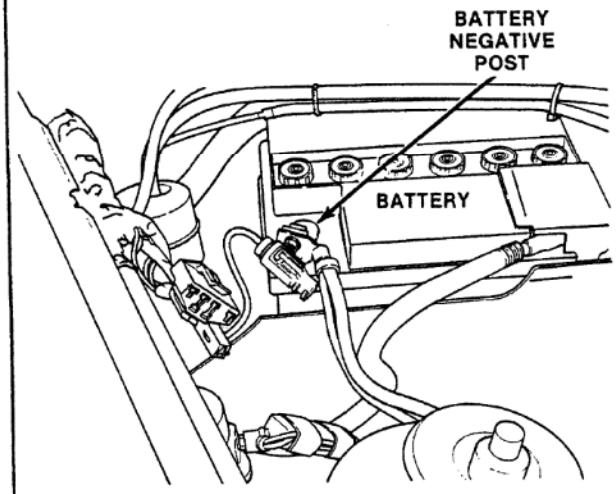
Installation

1. Position the proportioning valve and install the attaching bolt. Tighten the bolt securely.
2. Connect the brake lines.
3. Fill the master cylinder reservoir to the proper level and bleed the front and rear hydraulic systems. If necessary, refer to the procedure in this section. After bleeding, make sure the master cylinder reservoir is filled to the correct level.

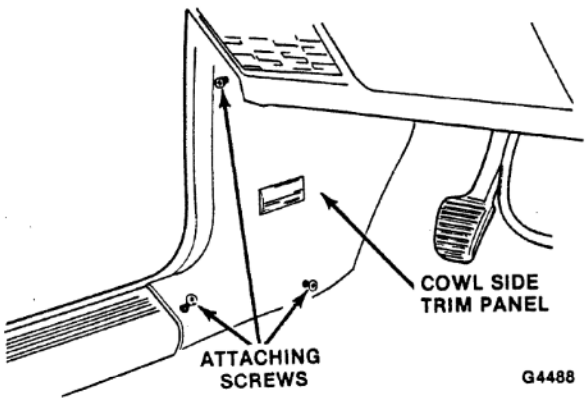
BRAKE PEDAL

Removal

1. Disconnect the battery negative cable.



2. Remove the sound deadening panel, located under the instrument panel.
3. Remove the side cowl trim panel attaching screws.

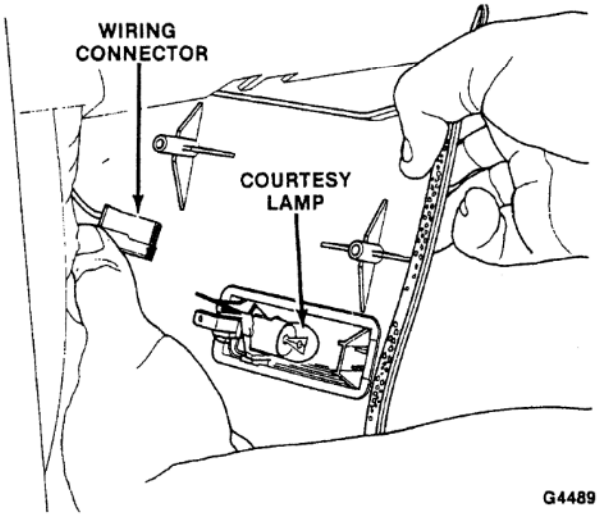


REMOVAL AND INSTALLATION

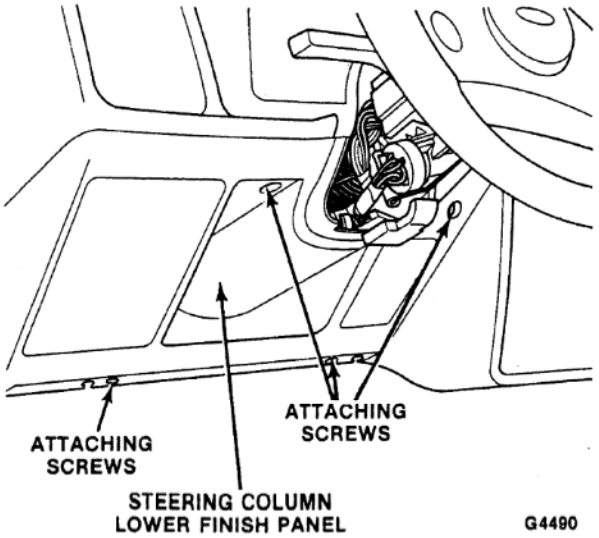
BRAKE PEDAL

Removal (Continued)

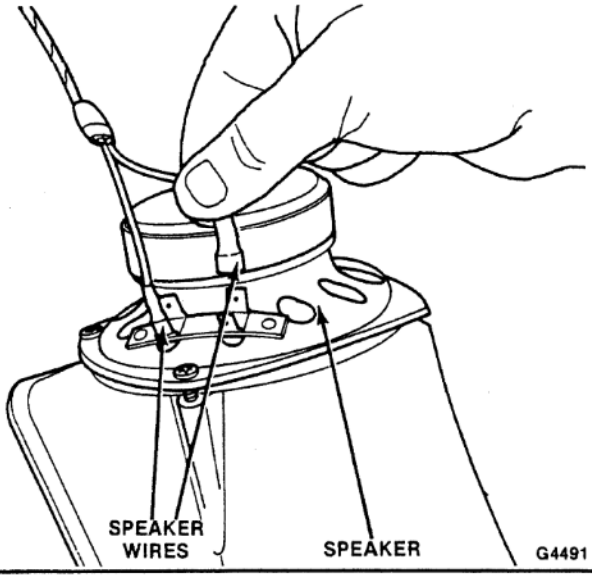
4. Pull the side cowl trim panel away from the body, disconnect the courtesy light wiring and remove the panel.



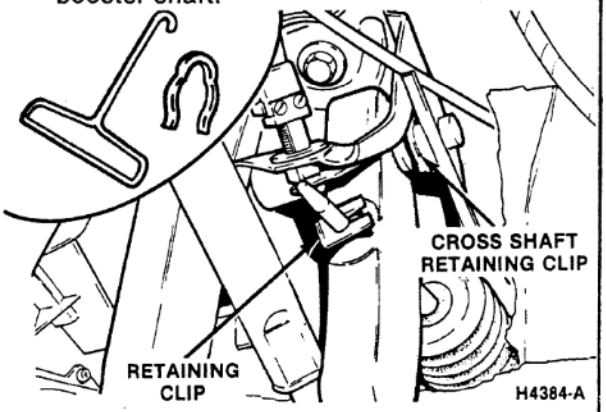
5. Remove the steering column lower shroud and the left lower instrument panel attaching screws.



6. Lower the instrument panel, disconnect the radio speaker wires and remove the panel.



7. Remove the retaining clip from the power booster shaft.



8. Using a suitable hook, remove the retaining clip, located on the cross shaft between the brake pedal and the shaft mounting bracket.

   Do not remove the retaining clip from the left end of the shaft.

9. Slide the shaft to the left to remove the shaft spacer and brake pedal.

NOTE: If the vehicle is equipped with a manual transmission, slide the shaft only enough to allow removal of the brake pedal.

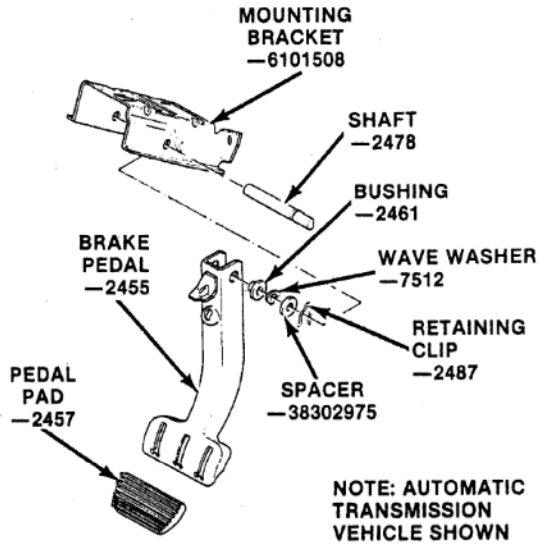
10. If necessary, remove the shaft bushing and pedal pad.

REMOVAL AND INSTALLATION

BRAKE PEDAL

Installation

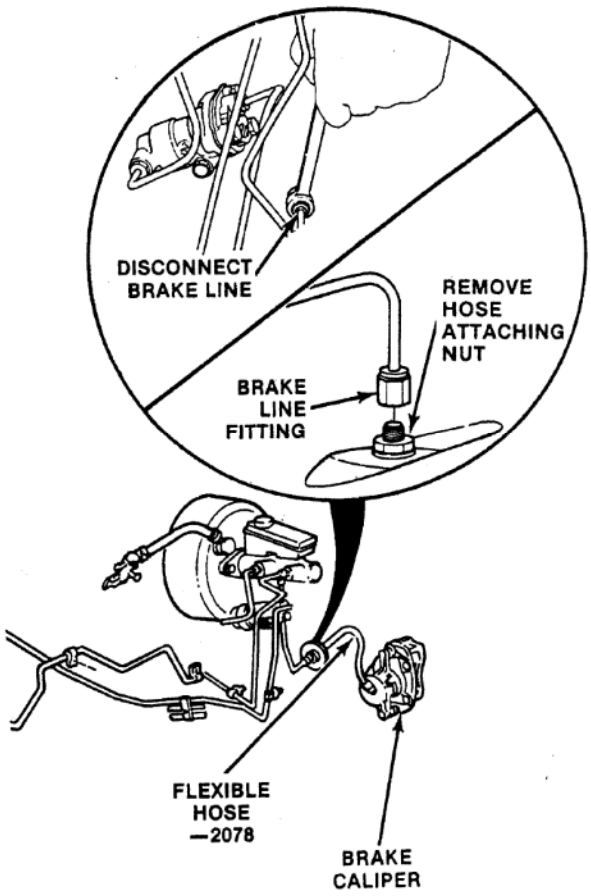
1. If necessary install the shaft bushings and pedal pad.
2. Make sure the brake pedal bushing is in position on the power booster shaft.
3. Position the brake pedal and slide the shaft through the bushings. Slide the shaft to the outer edge of the right-hand bushing and stop. Use care to prevent pushing the right-hand bushing out of position.
4. Position the shaft spacer and push the shaft through the spacer and mounting bracket.
5. Install the shaft retaining clip.
6. Install the retaining clip on the power booster shaft.
7. Position the left lower instrument panel, connect the radio speaker wires and install the attaching screws.
8. Install the steering column shroud.
9. Position the side cowl trim panel, connect the courtesy light wires and install the attaching screws.
10. Install the sound deadening panel.
11. Connect the battery negative cable.



CALIPER HOSE

Removal

1. Disconnect the brake line from the hose fitting in the engine compartment.

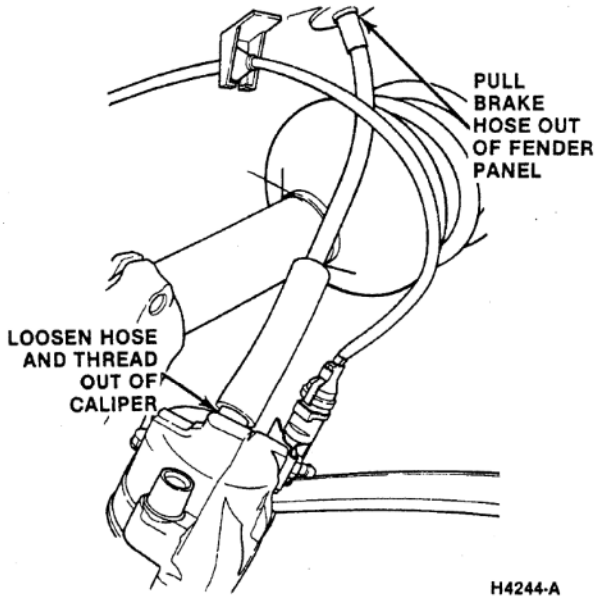


REMOVAL AND INSTALLATION

CALIPER HOSE

Removal (Continued)

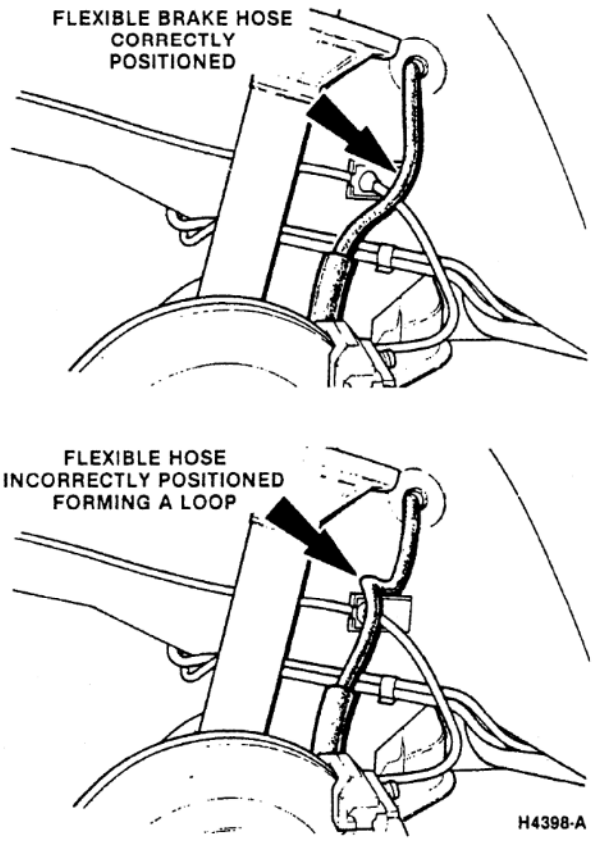
2. Remove the nut attaching the brake hose to the inner fender panel.
3. Raise the vehicle and remove the wheel.
4. Pull the brake hose out of the inner fender panel.
5. Loosen the brake hose fitting at the caliper and thread out-of-caliper.



Installation

1. Thread the brake hose into the caliper and tighten the fitting securely.
2. Position the end of the brake hose through the inner fender panel and install the attaching nut.

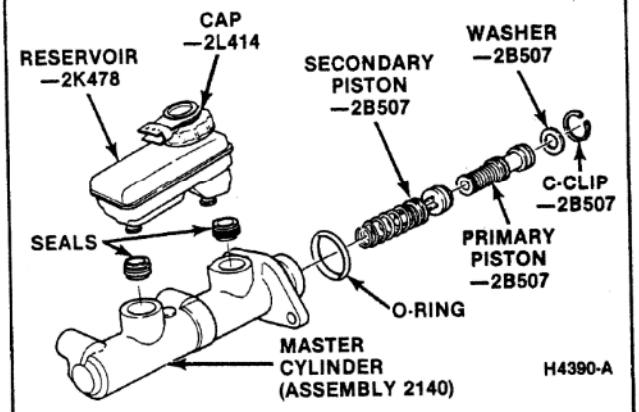
CAUTION: When the caliper hose is installed, make sure it has not been "kinked" during installation. A "wound-up" or "kinked" condition may cause the flexible hose to form a loop which tightens and rubs against itself when the front wheels are near the steering stops.



3. Connect the brake line fitting.
4. Bleed the front brake hydraulic system. If necessary, refer to the procedure in this section.
5. Install the wheel and lower the vehicle.

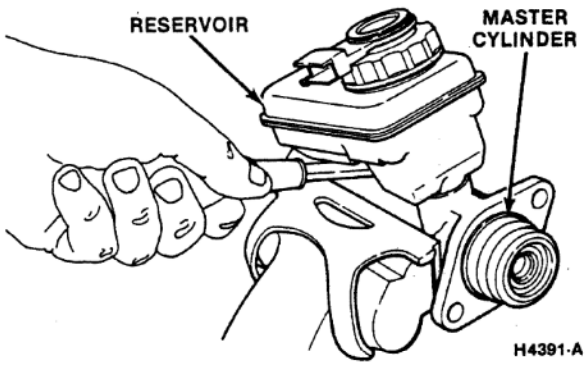
DISASSEMBLY AND ASSEMBLY

MASTER CYLINDER DISASSEMBLED VIEW

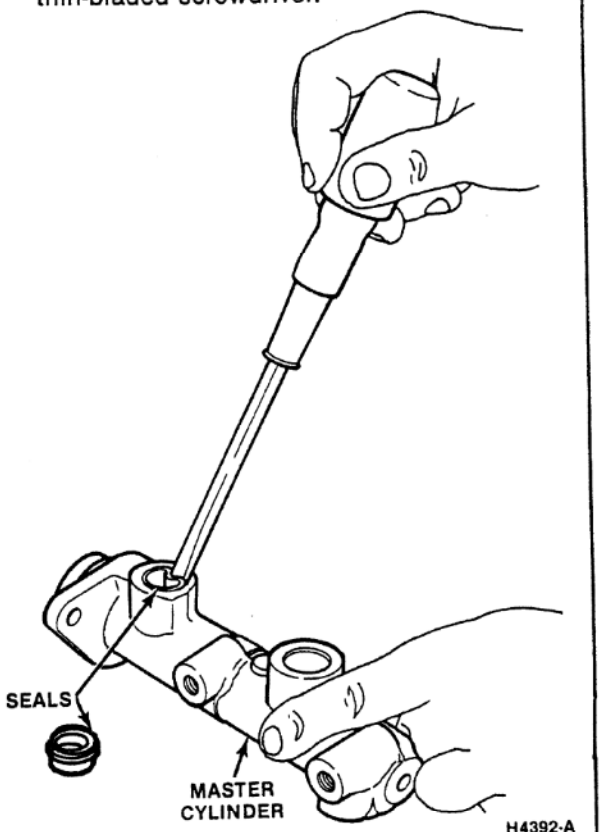


Disassembly

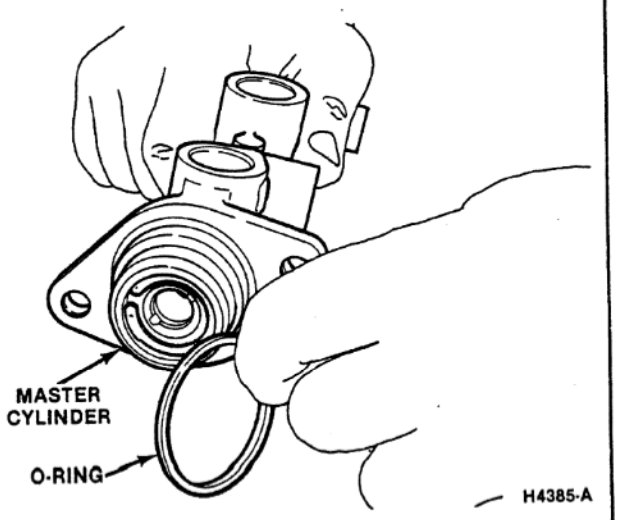
1. Remove the reservoir cap and drain the master cylinder reservoir.
2. Clamp the master cylinder in a vise, equipped with protective jaw caps.
3. Pry the reservoir out of the master cylinder seals.



4. Remove the master cylinder seals using a thin-bladed screwdriver.



5. Remove the O-ring.

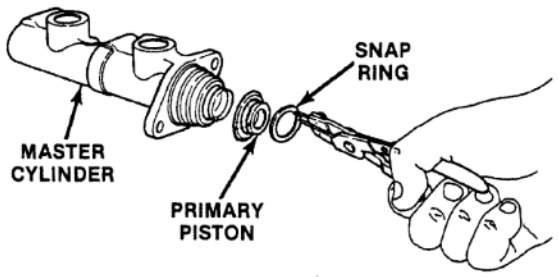


DISASSEMBLY AND ASSEMBLY

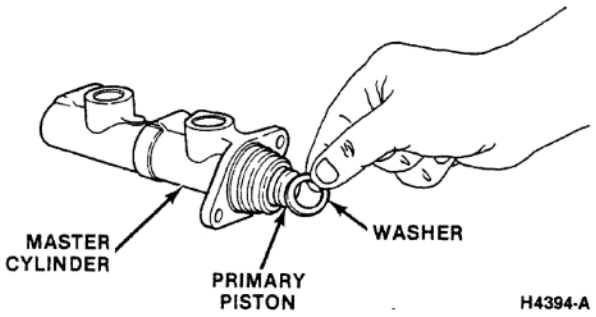
MASTER CYLINDER

Disassembly (Continued)

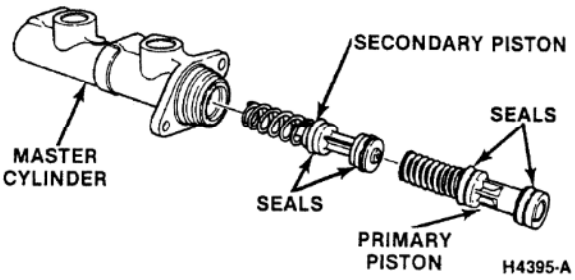
6. Push inward on the primary piston and remove the snap ring.



7. Remove the washer from the end of the primary piston.



8. Remove the primary piston.



9. Tap the master cylinder on a block of wood to remove the secondary piston.
10. Remove the seals from the primary and secondary pistons.

Assembly

NOTE: As the master cylinder parts are assembled, they must be lubricated with clean brake fluid.

1. Install new seals on the primary and secondary pistons.
2. Install the secondary piston. To prevent damage to the seal lip, ease the seal into the master cylinder bore while slowly rotating and pushing.
3. Install the primary piston. To prevent damage to the seal lip, ease the seal into the master cylinder bore while slowly rotating and pushing.
4. Push the primary piston into the master cylinder bore and install the washer and snap ring.
5. Install new reservoir seals in the master cylinder.
6. Install the reservoir.
7. Install the reservoir cap to prevent entry of dirt.

DISASSEMBLY AND ASSEMBLY

PRESSURE CONTROL VALVE

The pressure control valve is serviced only as an assembly.

GENERAL SERVICE PROCEDURES

HYDRAULIC SYSTEM FLUSHING

NOTE: The brake hydraulic system must be flushed if there is any doubt about the grade of the fluid in the system or if the system is suspected of containing even a trace of mineral oil.

If mineral oil has been used, all seals and hoses **MUST BE REPLACED.**

1. Using a line wrench, loosen and then tighten each of the four bleeder fittings.
2. Attach a length of rubber hose to each bleeder fitting and place the free end of each hose in a suitable container.

   The hose must fit snugly on the bleeder fitting.
3. Open all four bleeder screws.
4. Pump the brake pedal until the brake fluid is removed from the hydraulic system and air is being pumped through the system.

   As the system empties of brake fluid, allow the brake pedal to return before repeating a pump stroke.
5. Close the bleeder fittings on the wheel cylinders.
6. Spread the brake pads on both front calipers using Disk Brake Pad Spreaders D79L-2196-A, or equivalent.
7. While leaving the tools in place, continue pumping the brake pedal until only air is being pumped out of the brake caliper bleeder screws.
8. Open the bleeder fittings at the wheel cylinders.
9. Close the bleeder fittings on the calipers.
10. Fill the master cylinder with the specified brake fluid.
11. Alternately pump the brake pedal and fill the master cylinder until clean brake fluid is pumped into the containers at the wheel cylinders.
12. Close the wheel cylinder bleeder fittings.
13. Open the caliper bleeder fittings.
14. Place the bleed tubes from the calipers in glass jars containing a small quantity of approved brake fluid. Position the jars at least 300 mm (12 in.) above the bleed nipples. This is to ensure that the bleed nipple itself is subjected to fluid pressure, thereby preventing air from leaking past the threads of the bleed nipple and into the braking system.
15. Alternately pump the brake pedal and fill the master cylinder until clean, air-free brake fluid is pumped into the jars at the calipers.
16. With the brake pedal fully depressed, close the caliper bleeder screws.
17. Top off the brake reservoir with new fluid as required.
18. Remove the caliper spreaders and depress the brake pedal to move the caliper pistons to the fully extended position.
19. With the pedal still depressed, open the caliper bleeder fittings.
20. Force the piston back to its fully retracted position with Caliper Spreaders D79L-2196-A, or equivalent, and close the caliper bleeder screws.
21. Remove the caliper spreaders.
22. Bleed the entire brake system. If necessary, refer to the procedure in this section.

GENERAL SERVICE PROCEDURES

HYDRAULIC SYSTEM BLEEDING

When any part of the brake hydraulic system has been disconnected for service, air will enter the system and cause spongy pedal action. To remove the air, the system must be bled using either pressure bleeding equipment or the manual method. If only one system has been opened, normal pedal feel can usually be restored by bleeding only the opened system. Bleed the longest line first on the system being bled. The following can serve as a guide when determining which line to bleed first:

- REAR ONLY
  — Right side first
- FRONT ONLY
  — Right side first
- FRONT AND REAR
  — Right rear
  — Left rear
  — Right front
  — Left front

Use only Ford Heavy Duty brake fluid meeting specifications ESA-M6C25-A, or DOT 3 equivalent (Ford Part Number C6AZ-19542-A).

SYSTEM PRIMING

Where a new master cylinder has been installed or the brake system emptied or partially emptied and fluid will not flow from the bleeder fittings during normal bleeding, it may be necessary to prime the system by using the following procedure:

1. Open one bleeder fitting and check to see if fluid flows freely.
2. If fluid flows freely, close that bleeder fitting and repeat the operation on the other bleeder fittings in turn.
3. Where fluid does not flow freely:
   a. With the fitting open, depress the brake pedal.
   b. With the pedal depressed, close the fitting.
   c. Release the pedal.
   d. Repeat until fluid flows freely.
4. Once fluid flows freely at all bleeder fittings, continue with the brake bleeding procedure outlined elsewhere in this section.

MANUAL BLEEDING

1. Clean all dirt from the master cylinder filler cap.
2. If the master cylinder is known or suspected of having air in the bore, it must be bled before any of the wheel cylinders or calipers. To bleed the master cylinder, proceed as follows:
   a. Loosen either the front or rear outlet fitting on the side of the master cylinder approximately ¾ turn.
   b. Have a helper push the brake pedal slowly down through its full travel.
   c. While the helper is holding the pedal down, tighten the master cylinder outlet fitting.
   d. Have the helper release the brake pedal and allow the pedal to return to the full-released position.
   e. Wait five seconds and then repeat these steps until air bubbles cease to appear at the outlet fitting.
   f. Repeat these steps at the remaining master cylinder outlet fitting.
3. To bleed the wheel cylinders and calipers, proceed as follows:
   a. Begin with the longest line.
   b. Attach a rubber drain hose to the bleeder fitting. The end of the tube should fit snugly around the end of the fitting.

GENERAL SERVICE PROCEDURES

c. Place the free end of the hose in a container partially filled with clean brake fluid. The bottom of the container should be at least 300 mm (12 in.) above the bleeder fitting.

d. Loosen the bleeder fitting approximately ¾ turn.

e. Have a helper push the brake pedal down through its full travel.

f. While the helper is holding the pedal down, close the bleeder fitting.

g. Have the helper release the brake pedal and allow the pedal to return to the full-released position.

h. Wait five seconds and then repeat these steps until air bubbles cease to appear at the submerged end of the rubber drain hose.

i. Repeat these steps at the remaining wheel cylinders or calipers.

PRESSURE BLEEDING

For pressure bleeding, use only a diaphragm-type bleeder and follow the manufacturer's instructions.

BRAKE TUBE REPLACEMENT

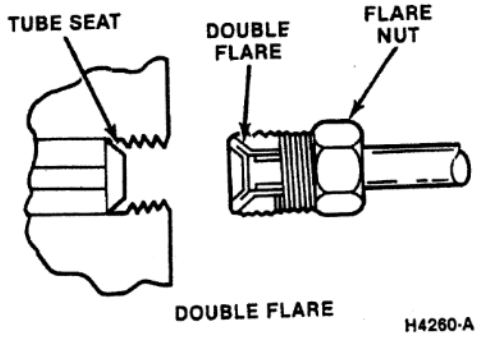
CAUTION: Never use copper tubing because copper is subject to fatigue, cracking, and corrosion which could result in brake failure. Use double-walled steel tubing.

To replace a brake tube use the general procedure outlined below.

1. Obtain the recommended tubing and steel fitting nuts of the correct size. (Outside diameter of tubing is used to specify size.)
2. Cut tubing to length. Correct length may be determined by measuring old pipe using a cord and adding 1/8″for each double flare.
3. Make sure fittings are installed before starting flare. Double flare tubing ends using a suitable flaring tool. Follow instructions included in the tool set.

NOTE: Double flaring tool must be used as single flaring tools cannot produce a flare strong enough to hold the necessary pressure.

4. Bend pipe assembly to match old pipe using a tubing bender. Clearance of 0.750″ must be maintained to all moving or vibrating parts.



GROUP 12 Specifications

BRAKE SYSTEM DESIGN:

- Four wheel hydraulic actuated system
- Split system—front to rear
- Front disc, rear drum

BRAKE CONTROL VALVE: Proportioning type, deceleration active

BRAKE BOOSTER:

- 1985/1986: 8", single diaphragm, vacuum actuated
- 1987: 8", dual diaphragm, vacuum actuated

ROTOR:

- Cast iron, ventilated
- Standard thickness—24.15mm (0.95 in.)
- Minimum allowable thickness—22.8mm (0.898 in.)

WHEEL CYLINDER:

- Bore— 22.2mm (0.87 in.)

MASTER CYLINDER:

- 1985/1986 Bore—23.8mm (0.94 in.)
- 1987—Bore 25.4mm (1 in.)

BRAKE LININGS:

- Minimum thickness—Disc—1.5mm (0.059 in.)
  Drum—1.0mm (0.040 in.)
- Lining attachment—Bonded

PARKING BRAKE: Cable actuated

BRAKE FLUID: DOT-3 or DOT-4
Ford Specification—ESA-M6C25-A (C6AZ-19542-A)

DRUM:

- Cast iron
- Standard diameter—254.0mm (10.0 in.)
- Maximum allowable diameter—255.55mm (10.06)

CAUTION: Do not machine brake drums. If the braking surface diameter has worn in excess of the maximum diameter shown in cast figures on the outside of the drum, replace the drum.

TORQUE SPECIFICATIONS

Item	N·m	lb-ft
Master cylinder to booster	21–29	16–20
Caliper to anchor	25–30	18–23
Anchor plate to front spindle	51–61	43–44
Wheel cylinder to backing plate	7–10	5–7

STEERING

GROUP 13 (3000)

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REMOVAL AND INSTALLATION
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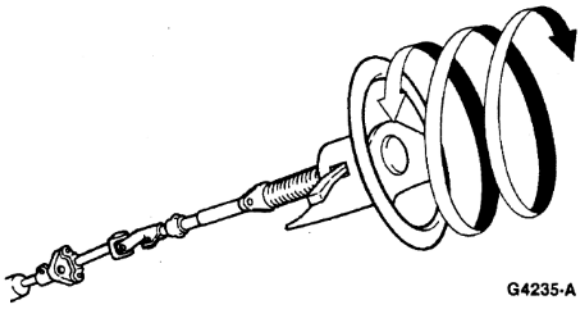
POWER STEERING HOSES 13-55

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SECTION 13-01 STEERING SYSTEM DIAGNOSIS

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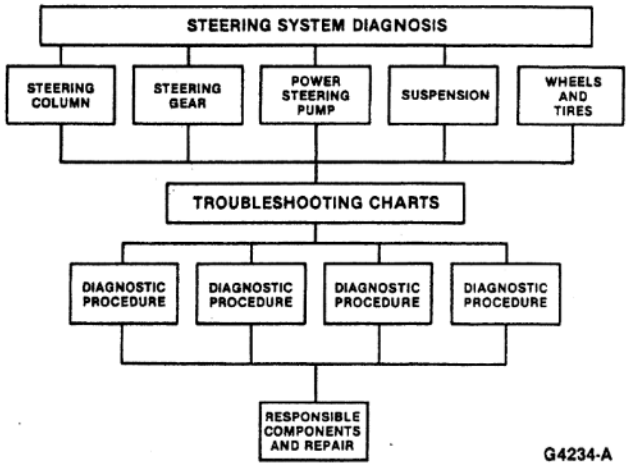


G4235-A

GENERAL INFORMATION

Steering system complaints usually fall into one of four categories: leaks, noise, excessive steering effort, or handling problems, such as wandering, loose feel, pulling to one side, or not returning freely to the straight-ahead position when the wheel is released. Causes of steering system problems can be found in any or all of four areas: the steering column, steering gear, power steering pump, or front suspension components, including wheels and tires.

For quick reference and detailed diagnosis, this section is divided into Troubleshooting Charts and Diagnostic Procedures. The Troubleshooting Charts can be used to quickly identify and describe a particular customer complaint and possible causes. The Diagnostic Procedures provide a detailed inspection procedure, which will pinpoint the component(s) causing many of these problems.

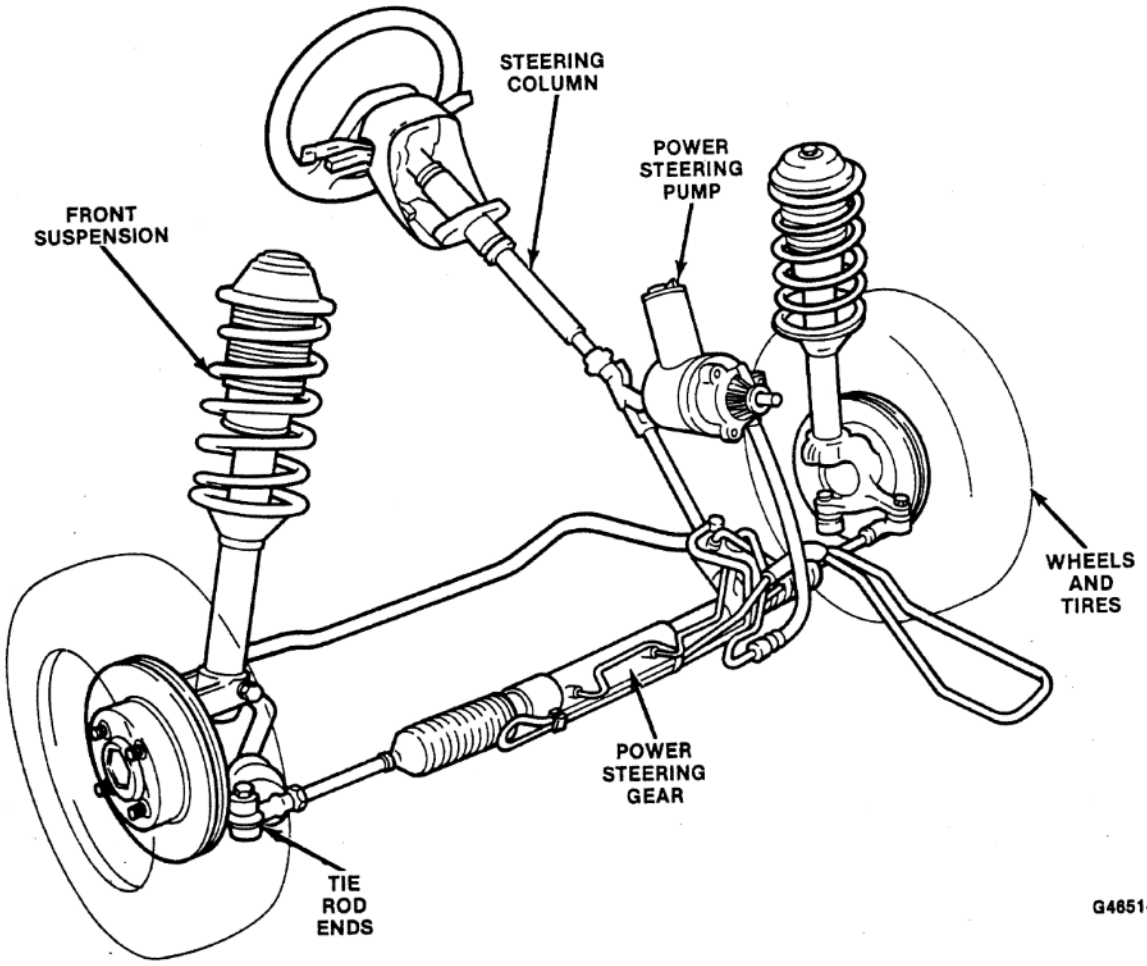


G4234-A

GENERAL INFORMATION

Any incorrect conditions discovered in an inspection process can contribute to a variety of steering system troubles. Few specific complaints can be attributed to a single specific cause. If inspection shows everything visible to be in good order, removal and/or partial disassembly of steering system components may be necessary to pinpoint the cause of a complaint.

Often, determining the most likely cause—and the best place to look first—is a matter of judgment and experience. Therefore, the Troubleshooting Charts that follow are just guidelines, and the possible causes of various conditions are not necessarily presented in order of decreasing probability.



TROUBLESHOOTING CHARTS

EXCESSIVE STEERING EFFORT

NOTE: Before proceeding into this Troubleshooting Chart, check the steering effort using a pull scale. If necessary, refer to item 11 in the Inspection Diagnostic Procedure.

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
• Excessive Steering Effort, Poor Assist or Loss of Assist is a condition recognized by the driver while turning corners and during parking maneuvers.	• Low pump fluid	• Check fluid level and fill as required. Check for leaks. If necessary, refer to Section 13-51 for the fill procedure and Leakage Troubleshooting Chart in this section.
	• Gear assembly external or internal leakage	• Refer to Excessive Steering Effort Diagnostic Procedure in this section.
	• Pump external leakage	• Refer to Leakage Troubleshooting Chart in this section.
	• Loose or worn drive belts	• Inspect drive belts. Replace or adjust tension as required. If necessary, refer to Section 27-02.
	• Hose or cooler external leakage	• Refer to Leakage Troubleshooting Chart in this section.
	• Improper engine idle speed	• Adjust idle. If necessary, refer to Section 21-01.
	• Pulley loose, warped or misaligned	• Replace pulley. If necessary, refer to Section 13-51.
	• Pump flow/pressure not to specifications	• If necessary, refer to the Pressure Test Diagnostic Procedure in this section.
	• Hose or cooler line restricted or kinked	• Clean or replace as necessary. A pressure test will determine if there is a restriction in one of the lines. If necessary, refer to the Pressure Test Diagnostic Procedure in this section.
	• System contamination	• Inspect system for contamination. If necessary, refer to Section 13-51 for the flushing procedure.

TROUBLESHOOTING CHART

PULLS TO ONE SIDE

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
• Excessive Steering Effort, Poor Assist or Loss of Assist is a condition recognized by the driver while turning corners and during parking maneuvers (Continued)	• Aerated fluid	• Purge the system of air. If necessary, refer to the procedure in this section.
• Pulls to One Side is a condition where the vehicle tends to pull to one side when driven on a level surface.	• Tire-related problem	• Refer to Section 11-01 for tire inspection and diagnostic procedures.
	• Vehicle is unevenly or excessively loaded	• Adjust load.
	• Damaged front suspension components or improper wheel alignment	• Inspect front suspension and check alignment angles. If necessary, refer to Section 14-01.
	• Damaged rear suspension components	• Inspect rear suspension. If necessary, refer to Section 14-01.
	• Steering gear valve effort out of balance	• Refer to Steering Pulls to One Side Diagnostic Procedure in this section.
	• Check front and rear brakes for proper operation.	• Adjust if necessary. Refer to Section 12-01 for inspection and diagnostic procedures.

TROUBLESHOOTING CHARTS

WANDER

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
• Wander—Vehicle wander is a condition where the vehicle wanders back and forth on the roadway when it is driven straight ahead while the steering wheel is held in a firm position. Evaluation should be conducted on a level road (little road crown).	• Tire-related problem	• Refer to Section 11-01 for tire inspection and diagnostic procedures.
	• Check if vehicle is unevenly loaded or overloaded.	• Adjust load.
	• Loose/worn tie rod ends or ball socket	• Replace tie rod end or tie rod assembly as necessary. If necessary, refer to Section 13-46.
	• Steering gear mounting insulators and/or attachment bolts loose or damaged	• Replace insulators and/or attachment nuts and bolts. Tighten to specification. If necessary, refer to Section 13-46.
	• Loose suspension struts	• Tighten strut mounting bolts. If necessary, refer to Section 14-10.
	• Column intermediate shaft loose	• Tighten to specifications at Gear and at Column. If necessary, refer to Group 13 Specification for correct torque values.
	• Column intermediate shaft universal joints loose/worn	• Replace intermediate shaft assembly. If necessary, refer to Section 13-04.
	• Improper wheel alignment	• Inspect front suspension and check alignment angles. If necessary, refer to Section 14-01.
	• Check steering gear rack yoke adjustment.	• If necessary, refer to Section 13-46.*

***NOTE:** If equipped with a ZF steering gear, rack yoke is not adjustable.

TROUBLESHOOTING CHARTS

POOR RETURNABILITY

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
• Poor Returnability—Sticky Feel is a condition noticed when the steering fails to center following a turn, without manual effort from the driver. In addition, when the driver returns the steering wheel to center, it may have a sticky or catchy feel.	• Improper tire pressure or other tire problem	• Refer to Section 11-01 for tire inspection and diagnostic procedures.
	• Column intermediate shaft universal joints binding	• Replace intermediate shaft assembly. If necessary, refer to Section 13-04.
	• Check for boot tears and/or evidence of binding or damage to tie rod ends or ball joints.	• Replace as necessary. If necessary, refer to Section 13-46.
	• Damaged/worn front suspension components	• Inspect struts and lower control arm ball joints. If necessary, refer to Section 14-01.
	• Improper wheel alignment	• Inspect front suspension and check alignment angles. If necessary, refer to Section 14-01.
	• Steering column bearing binding	• Replace bearing. If necessary, refer to Section 13-04.
	• System contamination	• Inspect the system for contamination. If necessary, refer to Section 13-51 for the flushing procedure.
	• Check steering rack yoke adjustment.	• If necessary, refer to Section 13-46.*

***NOTE:** If equipped with a ZF steering gear, rack yoke is not adjustable.

TROUBLESHOOTING CHARTS

NOISE

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
• Feedback (Rattle, Chuckle, Knocking Noises in Steering Gear) is a condition where roughness is felt in the steering wheel by the driver when the vehicle is driven over rough pavement.	• Steering column intermediate shaft joints loose/worn	• Replace intermediate shaft assembly. If necessary, refer to Section 13-04.
	• Loose tie rod end(s) and/or tie rod inner ball joints	• Replace tie rod end(s) and/or tie rod assemblies. If necessary, refer to Section 13-46.
	• Steering gear mounting insulators and/or attaching bolts loose or damaged	• Replace insulators and/or tighten attachment bolts to specifications. If necessary, refer to Section 13-46.
	• Steering column intermediate shaft connecting bolts loose	• Tighten bolts to specification. If necessary, refer to Group 13 Specifications for correct torque values.
	• Loose suspension bushings/fasteners or ball joints	• Tighten suspension fasteners, replace worn bushings, or replace front control arms. If necessary, refer to Section 14-10.
*NOTE: If equipped with a ZF steering gear, rack yoke is not adjustable.	• Check steering gear rack yoke preload adjustment.	• If necessary, refer to Section 13-46.*
	• Check steering column conditions.	• Refer to Poor Returnability Diagnostic Procedure in this section.
• Noise/Rattle (Steering Column)	• Loose bolts/attaching brackets	• Tighten to specification. If necessary, refer to Group 13 Specifications.
	• Looseness of ball bearings or insufficient lube	• Lube or replace bearings. If necessary, refer to Section 13-04.
	• Flex coupling compressed or extended	• Reposition shaft assembly to flatten flex coupling.
• Noise/Squeak or Cracks (Steering Column)	• Loose or mispositioned shrouds	• Tighten or reposition shrouds as required. If necessary, refer to Steering Column Installation in Section 13-04.
	• Upper or lower bearing out of position	• Disassemble column and inspect bearings. If necessary, refer to Section 13-04.

TROUBLESHOOTING CHARTS

NOISE (Cont'd)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
• Click	• A noise caused by the pump slippers being too long, broken slipper springs, excessive wear, nicked rotors and damaged cam contour	• Disassemble pump and inspect rotating group components. If necessary, refer to Section 13-51.
• Power steering pump—noise, moan or whine	• Fluid aeration	• Purge the power steering system to reduce aeration noise. If necessary, refer to the procedure in this section.
	• Low fluid	• Check fluid level and fill as required. Check for leaks. If necessary, refer to Section 13-51 for fill procedure and Leakage Troubleshooting Chart in this section.
	• Hose grounded	• Check for grounded hoses.
	• Column grounded	• Check column alignment.
	• Valve cover O-ring or baffle missing/damaged	• Disassemble pump to valve cover. Remove and replace O-ring and baffle. If necessary, refer to Section 13-51.
	• Interference between components in pumping elements	• Disassemble pump and inspect rotating group components. If necessary, refer to Section 13-51.
	• Loose or poor bracket alignment	• Check bracket alignment and bolt torque. Correct if required.
• Swish	• A noise created by the flow of excessive fluid into the bypass port of the pump valve housing (with temperature below 130°). The shearing effect of the cooler (heavier) oil is not harmful to pump operation.	• A normal condition. Noise will diminish with fluid temperature increase.

TROUBLESHOOTING CHARTS

NOISE (Cont'd)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
• System Noise: Chirp or squeal when steering wheel is cycled lock to lock	• Loose or worn drive belts	• Inspect drive belts. Replace or tension as required. If necessary, refer to Section 27-02.
• Other suspected pump noises	• Internal pump wear or damage	• Disassemble pump and inspect components. If necessary, refer to Section 13-51.

EXTERNAL LEAKAGE

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
• Pump leaks	• Excessive fluid fill	• Check fluid level and adjust to proper level. If necessary, refer to Section 13-51.
	• Dipstick missing, loose, damaged or missing O-ring	• Service or replace if required.
	• Broken/cracked reservoir	• Replace reservoir. If necessary, refer to Section 13-51.
	• Loose or damaged hose fittings	• Service or replace. If necessary, refer to Section 13-55.
	• Leakage at shaft seal 1. Shaft seal not pressed in flush with housing surface	1. Use an appropriate seal installation tool to correct installation; if not possible or still leaking, replace seal. If necessary, refer to Section 13-51.

TROUBLESHOOTING CHARTS

EXTERNAL LEAKAGE (Cont'd)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
• Pump leaks (Cont'd)	2. Seal damage	2. Replace seal. If necessary, refer to Section 13-51.
	3. Rotor shaft damage, such as helical grooving, or the OD has an axial scratch	3. Replace shaft and seal. If necessary, refer to Section 13-51.
	4. Shaft bushing worn	4. Replace plate and bushing assembly. If necessary, refer to Section 13-51.
	5. Plugged drainback hole	5. Disassemble pump and clean drainback hole. If hole is not drilled through, replace plate and bushing assembly. If necessary, refer to Section 13-51.
	• Damaged or missing reservoir O-ring	• Replace O-ring. If necessary, refer to Section 13-51.
	• Damaged or missing outlet fitting O-rings	• Replace O-rings. If necessary, refer to Section 13-55.
	• Loose outlet fitting	• Tighten outlet fitting. If necessary, refer to Section 13-55.
	• Excessive pump assembly bracket vibration	• Correct bracket alignment and tighten bracket bolts to specification. If necessary, refer to Group 13 Specifications.
	• Plate and bushing reservoir seal groove porosity/damage, metal chips or foreign material on seal or in seal groove	• Disassemble pump to clean groove; replace plate and bushing assembly if damaged. If necessary, refer to Section 13-51.
	• Outlet fitting damage	• Replace outlet fitting. If necessary, refer to Section 13-55.

TROUBLESHOOTING CHARTS

EXTERNAL LEAKAGE (Cont'd)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
• Gear Leakage	• Pressure or return line fittings	• Disconnect lines from gear and inspect O-ring seals, fittings and tube seats. If necessary, refer to Section 13-55.
	• Fittings on rack piston tube	• Tighten fittings using a line wrench. If leak continues, disconnect fluid line and inspect fitting and tube seat for damage.
	• Loose hose clamp at secondary cooler	• Tighten clamps. If leak continues, disconnect hose and inspect for damaged cooler tube or hose.
	• Input shaft seal	• Remove steering gear and replace seal. If necessary, refer to Section 13-46.*
	• Damaged cooler tubes	• Replace tubes as necessary. If necessary, refer to Section 13-55.*

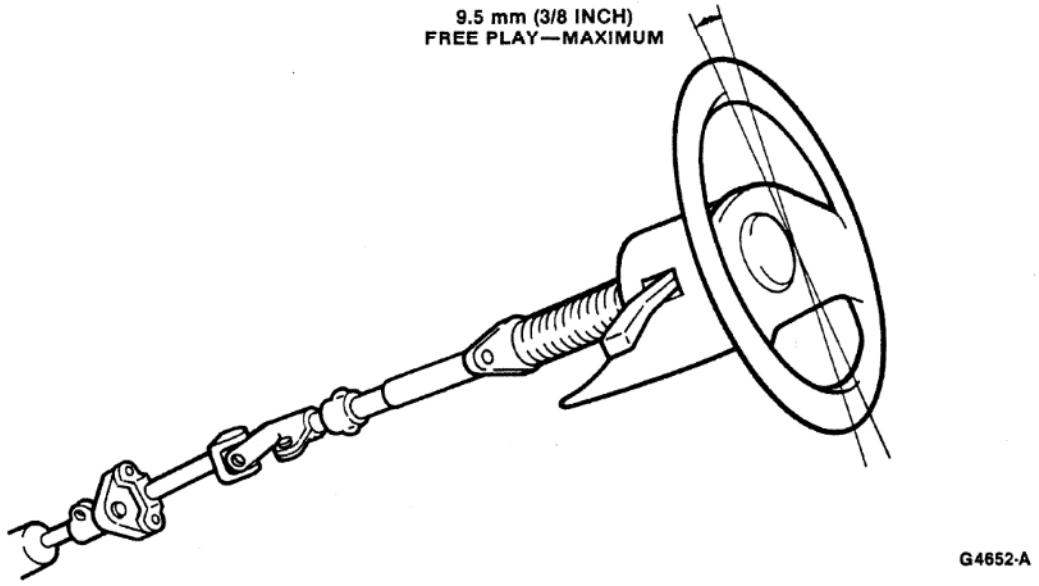
***NOTE:** If equipped with a ZF steering gear, replace with a service gear assembly.

DIAGNOSTIC PROCEDURES

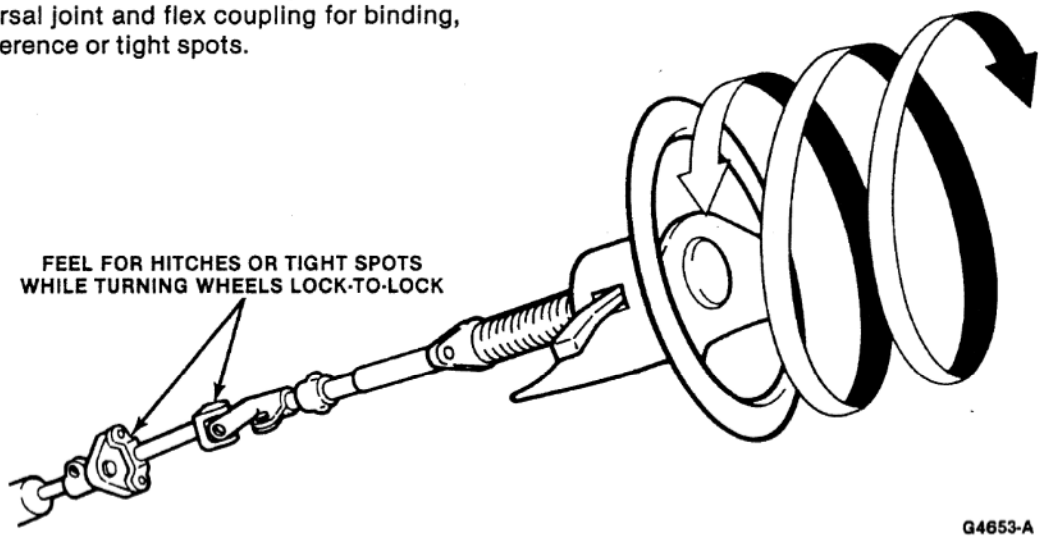
INSPECTION

The first step in diagnosis is a thorough inspection of the entire system from steering wheel to road wheels.

1. Check steering wheel free play in the straight-ahead position. It should not be more than 9.5 mm (3/8 inch) at the rim of the wheel. If excessive, a check under the hood will determine whether it's due to lost motion in steering column components, or in the steering gear and suspension components.



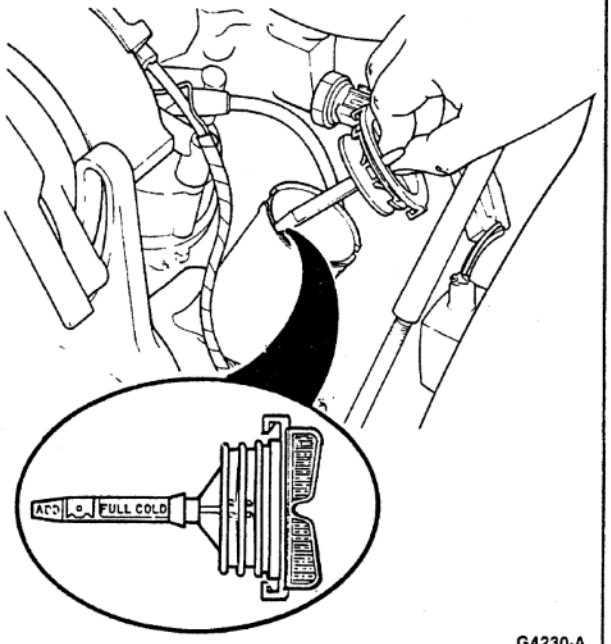
2. With front wheels raised, turn the wheel from lock to lock while checking the column universal joint and flex coupling for binding, interference or tight spots.



DIAGNOSTIC PROCEDURES

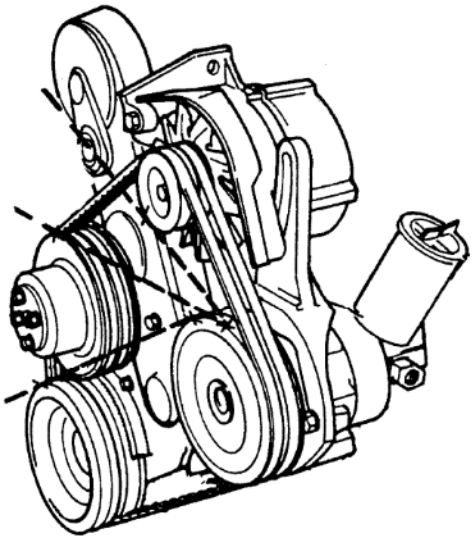
INSPECTION (Continued)

3. Check the fluid level in the pump reservoir. Overfilling may have caused apparent leakage at the pump. Look for air bubbles in the reservoir. If present, purging the system may resolve the complaint. If necessary, refer to the purging procedure in this section.



G4230-A

4. Check the condition and tension of the pump drive belts. If glazed or cracked, they could be slipping, causing excessive noise and reduced power assist. Check the pump pulley alignment with water pump, alternator and crankshaft pulleys, and make sure the pump mounting bracket is correctly positioned and securely installed.

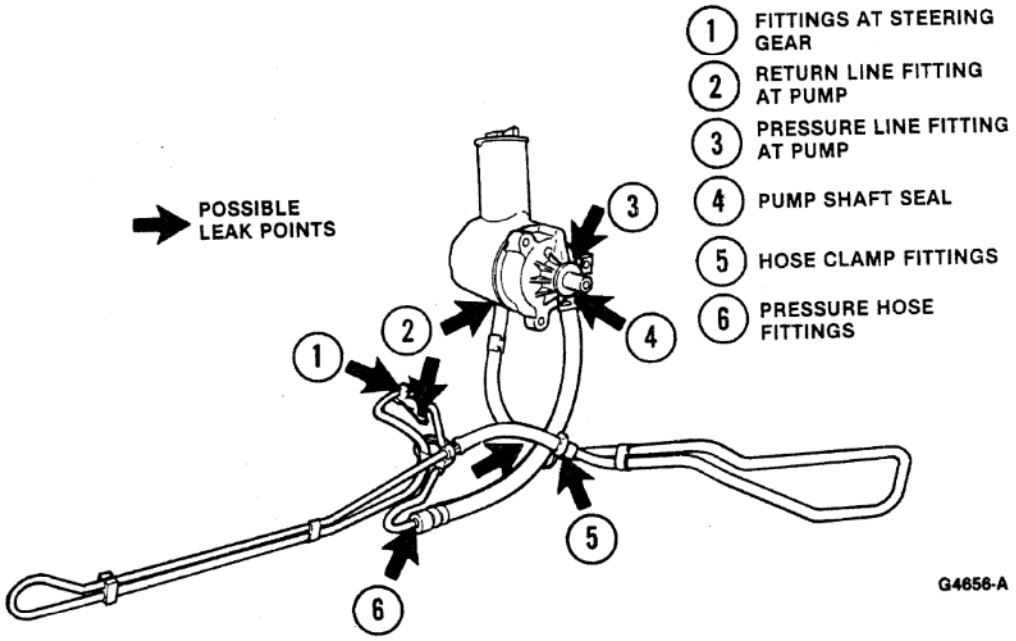


PULLEYS MUST BE ALIGNED IN SAME PLANE G4655-A

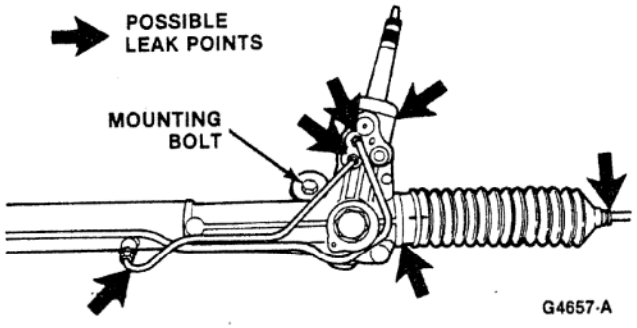
DIAGNOSTIC PROCEDURES

INSPECTION (Continued)

5. Check the pump outlet and return hoses, and cooler lines, for signs of leakage between the pump and steering gear.



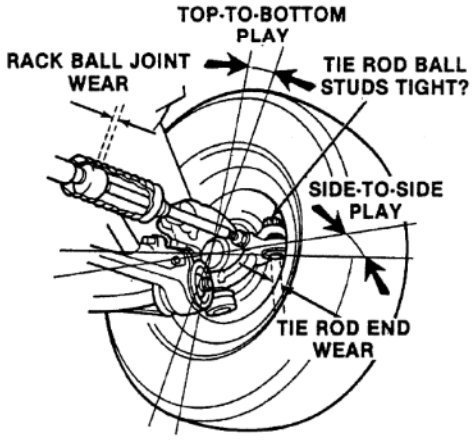
6. Check the steering gear for leakage at the pump connections, pinion shaft bore, transfer tube fittings, and tie rod boot ends, and verify that the steering gear is securely mounted on the crossmember. If necessary, refer to the mounting bolt tightening procedure in Section 13-46.



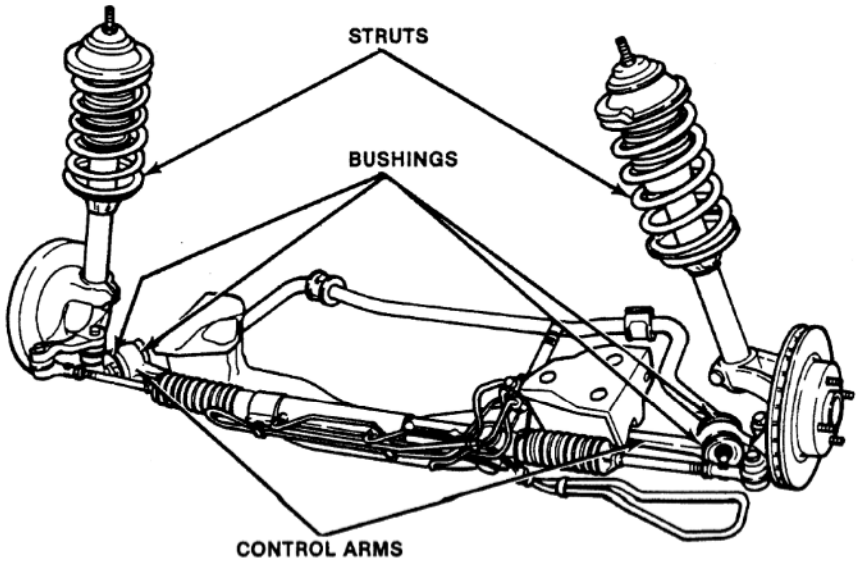
DIAGNOSTIC PROCEDURES

INSPECTION (Continued)

7. Check front wheels for side-to-side play, indicating wear in tie rod ends or rack ball joints. Verify that tie rod end ball studs are securely mounted in the wheel spindle supports. Also check for front wheel top-to-bottom play, indicative of worn wheel bearings. If necessary, refer to Section 11-16 for front wheel bearing service.



8. Inspect front suspension control arms, bushings and struts for signs of wear or damage that could impair steering control. If necessary, refer to Section 14-01 for front end alignment checking procedures.



DIAGNOSTIC PROCEDURES

INSPECTION (Continued)

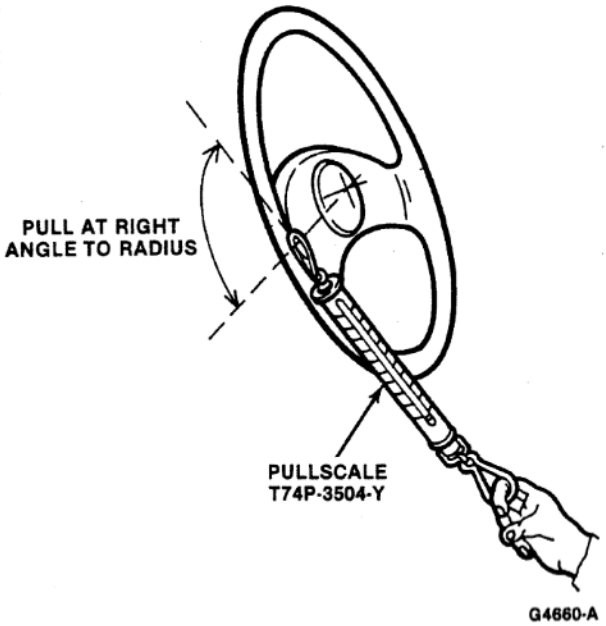
9. Verify that front tires are matched, equally worn and equally inflated.
10. Check for uneven side-to-side load distribution in the vehicle.
11. Check the steering effort to determine if the system is developing the proper amount of power assist as follows:

    With the vehicle parked on dry concrete and with the parking brake set, idle the engine for two to three minutes while turning the steering wheel left and right several times to bring the fluid up to normal operating temperature.

    Then, with the wheels in the straight-ahead position, hook a pull scale to one of the steering wheel spokes, as close as possible to the wheel rim, and measure the force required to turn the wheel.

    Keep the line of pull tangential to the wheel rim, that is, at a right angle to the wheel radius at the point of scale attachment, while turning the wheel one complete revolution in each direction from the center position.

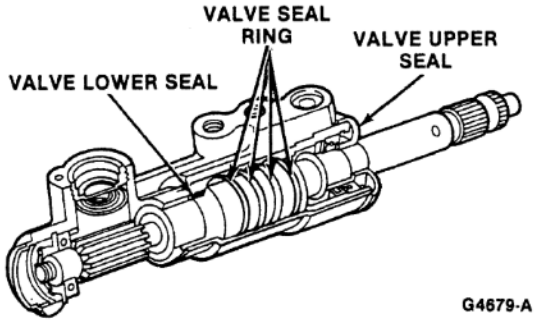
    Steering effort would be considered excessive if steering wheel rim pull exceeds 4.5 Kg (10 lbs.).



EXCESSIVE STEERING EFFORT

If the steering wheel rim pull test shows steering effort in excess of 4.5 Kg (10 lbs.) and no mechanical interference or binding is found in the steering column or suspension components, it is likely that the hydraulic system is not developing as much power assist as it should. Either pump output is being dissipated by internal leakage in the steering gear, or pump output is not up to specification. Steering gear internal leakage past the seals at either end of the rack cylinder would result in fluid being present in one or both tie rod boots, which might not show up in inspection if the boots are tightly sealed to the housing and the tie rods. Release the boot clips of the gear and pull the boots free of the housing to check for fluid. If any is found, the steering gear must be overhauled.*

***NOTE:** If equipped with a ZF steering gear, replace with a service gear assembly.



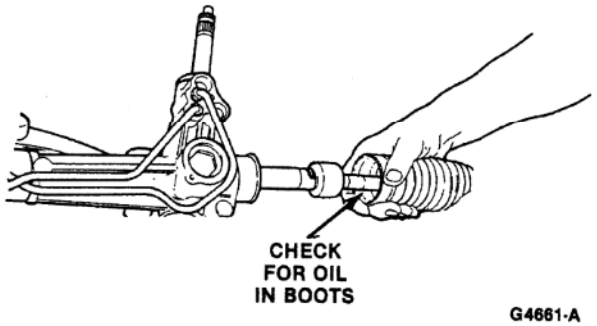
DIAGNOSTIC PROCEDURES

EXCESSIVE STEERING EFFORT (Continued)

Fluid in the left boot could result from leakage past the pinion and control valve shaft lower seal, rather than the rack inner seal, but in either case it indicates a condition requiring steering gear removal and disassembly to correct.* Also, presence of fluid in both boots is inconclusive, since the rack is hollow, with breather holes at each end to prevent pressure buildup in the boots.

If no fluid is found in the boots, steering gear internal leakage still cannot be ruled out, since leakage past the rack piston seal or control valve seals will not show up in the boots or elsewhere, but may seriously reduce power assist even if pump output is satisfactory.

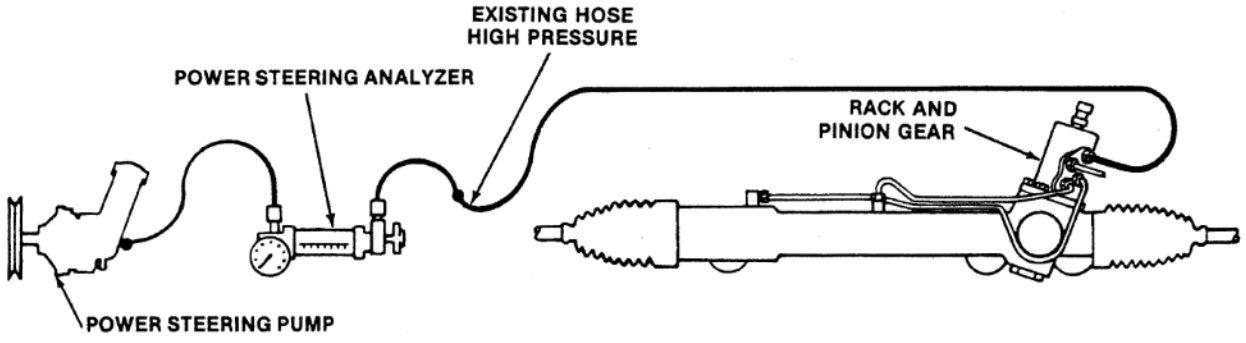
***NOTE:** If equipped with a ZF steering gear, replace with a service gear assembly.



G4661-A

PUMP PRESSURE AND FLOW TESTS

The next step is to determine whether pump output is satisfactory. If inspection found fluid level correct and free of air bubbles, pump pressure and flow characteristics should be checked with the Power Steering Analyzer (Rotunda 014-00207, or equivalent). Disconnect the pressure hose at the pump outlet fitting and connect the Analyzer between the fitting and the hose. Tighten the hose and fitting connections to no more than 20 N·m (15 lb-ft) and make sure the Analyzer gate valve is open before beginning the tests.



INSTALLATION OF THE ANALYZER AT THE PUMP OUTLET IS PREFERRED. IF IT IS DIFFICULT TO ATTACH THE ANALYZER AT THE PUMP, IF MAY BE INSTALLED AT ANY CONVENIENT LOCATION BETWEEN THE PUMP AND GEAR.

G2444-A

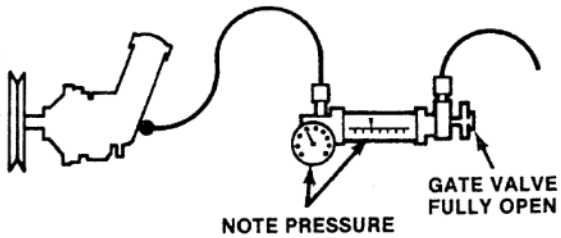
DIAGNOSTIC PROCEDURES

PUMP PRESSURE AND FLOW TESTS (Continued)

No-load Pressure and Flow Test

Check engine idle speed against specification and adjust if necessary. Idle the engine for about 2 minutes to bring fluid up to normal operating temperature (170°+5°F, or 77°+3°C). With Analyzer gate valve fully open, note pressure and flow rate. A flow rate less than 2 gpm suggests that the pump is defective, which can be confirmed by further testing. A pressure reading greater than 150 psi indicates restrictions in the hoses and lines between pump and steering gear.

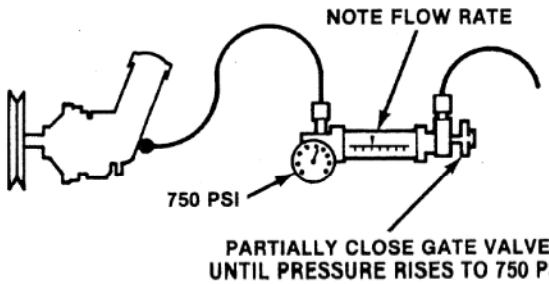
TEST NO. 1—NO-LOAD PRESSURE AND FLOW TEST
ENGINE IDLING—FLUID WARM



750-psi Flow Test

With engine idling, partially close the analyzer gate valve until pressure rises to 750 psi, and note the flow rate. If less than .95 gpm, the pump cam and rotor assembly must be replaced, as well as the pressure plates, if they are cracked or worn. If necessary, refer to Section 13-51 for pump rebuild procedures.

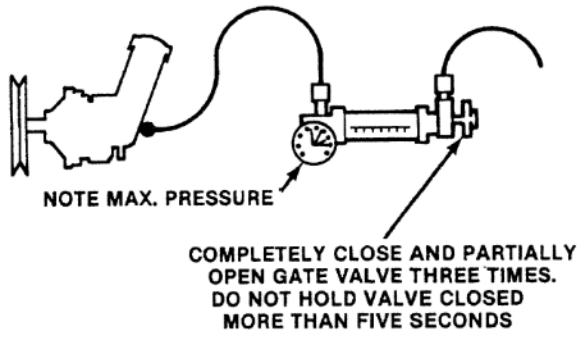
TEST NO. 2—750 PSI FLOW TEST
ENGINE IDLING—FLUID WARM



Relief Pressure Test

With engine idling, completely close and partially open the Analyzer gate valve 3 times, noting the maximum pressure reached. **Do not hold the valve closed more than 5 seconds at a time.** Relief pressure should be between 950–1130 psi. If below minimum by 100 psi or more, the pump flow control valve should be replaced. If over 50 psi above maximum, the valve should be inspected, and cleaned or replaced. If necessary, refer to Section 13-51.

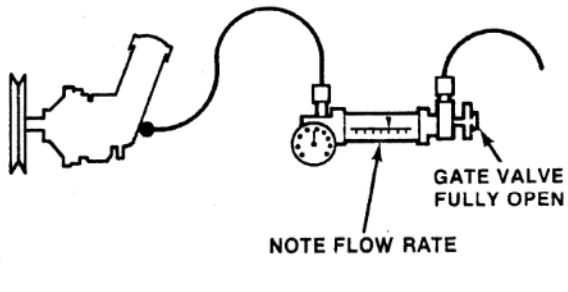
TEST NO. 3—RELIEF PRESSURE TEST
ENGINE IDLING—FLUID WARM



1500-rpm Flow Test

With the Analyzer gate valve fully open, increase engine speed to 1500 rpm and note the flow rate. If in excess of 2.1 gpm, the pump flow control valve should be inspected, and cleaned or replaced. If necessary, refer to Section 13-51.

TEST NO. 4—1500 RPM FLOW TEST
INCREASE ENGINE SPEED TO 1500 RPM



DIAGNOSTIC PROCEDURES

CONTROL VALVE RESPONSE TEST

With engine idling, turn the steering wheel slightly, in each direction, and release quickly while observing the pressure gauge. Pressure should fluctuate momentarily when the wheel is turned, and snap back to the normal pressure reading when the wheel is released. If it returns slowly or to a different value, the steering gear control valve is sticking and should be cleaned or replaced. If necessary, refer to Section 13-46.*

Full-lock Tests

With engine idling and Analyzer valve fully open, turn the steering wheel to full right and left lock stops while observing the Analyzer. **Do not hold the wheel at full lock any longer than necessary to note pressure and flow readings.** Pressure should be nearly the same as the relief pressure obtained by closing the Analyzer valve, and flow should drop below 0.5 gpm. If pressure is lower or flow higher, excessive internal leakage in the steering gear is indicated. If necessary, refer to Section 13-46 for steering gear repair procedures.*

***NOTE:** If equipped with a ZF steering gear, replace with a service gear assembly.

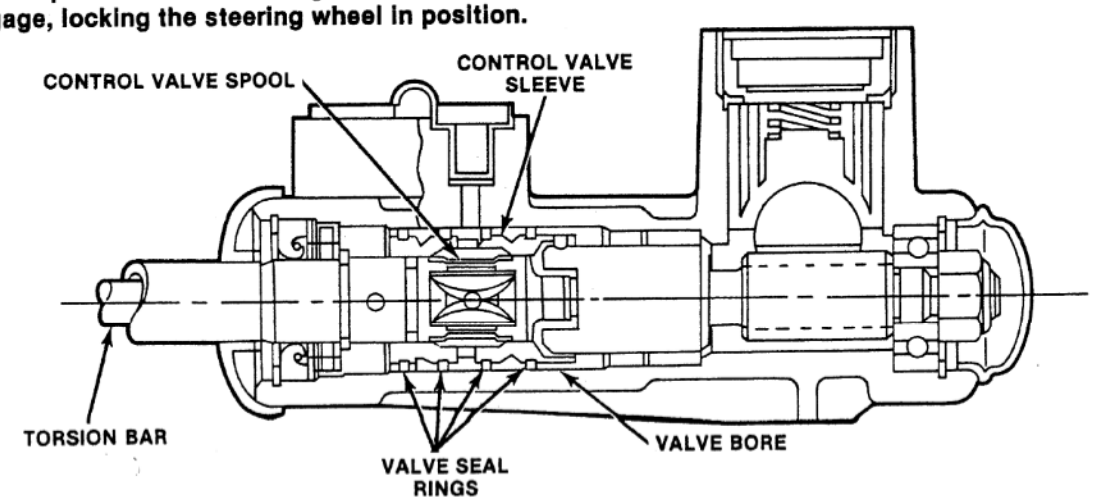
PULLS TO ONE SIDE

The possible causes of a steering pull condition are numerous, but road testing can quickly narrow them down. If inspection revealed a mismatch in front tire size, type or inflation, or uneven vehicle loading, correct the unbalanced condition and road-test to see if the pull condition persists. Use a section of level, uncrowned road for the test and drive the vehicle in both directions to allow for wind effects. If the pull condition is unchanged, try coasting in Neutral with the engine off, to eliminate steering pump output.

WARNING: Do not turn the ignition key to the locked position. The steering wheel lock will engage, locking the steering wheel in position.

If the pull condition disappears, the steering gear control valve is not maintaining the proper pressure balance in the steering gear, and must be repaired or replaced. Valve repair is limited to seal ring replacement, and if the seal rings are not unequally worn or damaged, and if the valve bore in the steering gear housing is not nicked or scored, pressure imbalance indicates internal damage in the valve assembly or a sprung torsion bar. If necessary, refer to Section 13-46.*

***NOTE:** If equipped with a ZF steering gear, replace with a service gear assembly.



DIAGNOSTIC PROCEDURES

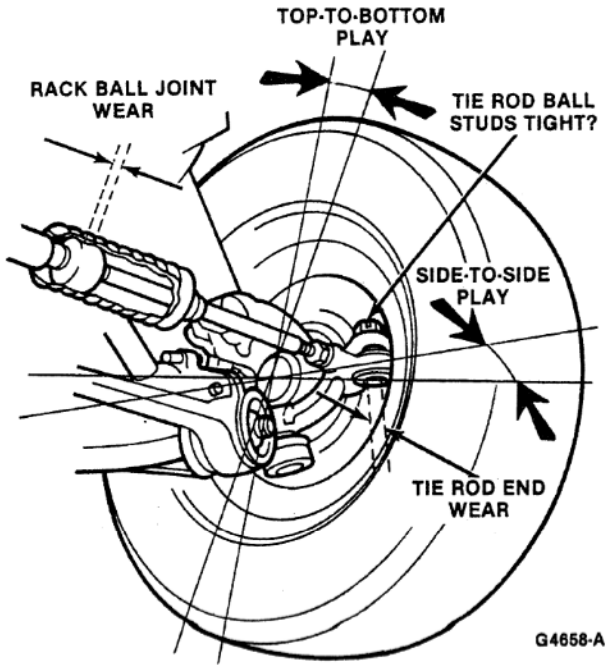
PULLS TO ONE SIDE (Continued)

If the coasting test does not eliminate the pull condition, the problem is not in the steering gear. To check for front tire inequalities not detected in inspection, cross-switch the front wheel and tire assemblies and repeat the road test. If the direction of the pull is reversed, recross-switch the front wheels to the rear, and switch the rear wheels and tires to the front, same sides.

If cross-switching the front tires does not change the direction of the pull, check the front suspension alignment. If necessary, refer to Section 14-01 for suspension specifications. Also, check for brake drag at front or rear wheels, and check both front and rear suspension systems for spring sag, and worn or damaged suspension components or mounting points.

WANDER

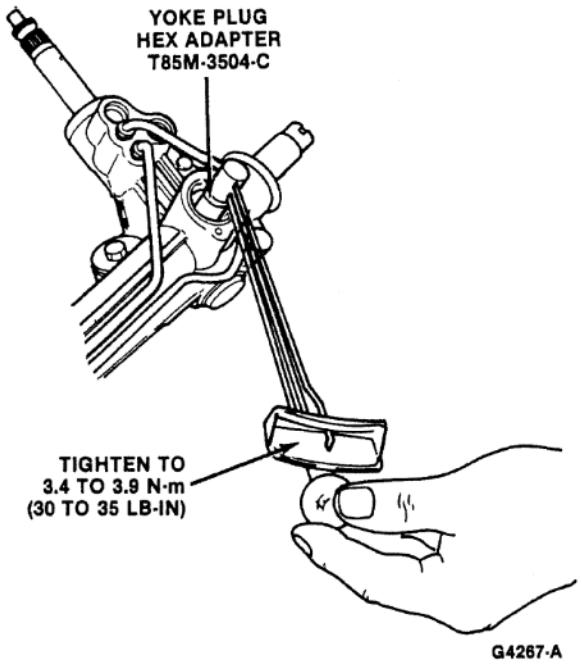
In general, loose steering and a tendency to wander result from lost motion somewhere between steering wheel and road wheels, which should be detected by inspection. Checking steering wheel freeplay while holding the steering gear pinion shaft against turning can quickly rule out the steering column universal joint and flex coupling as a source of lost motion. Likewise, front wheel wobble checks, top-to-bottom, and side-to-side will quickly pinpoint wheel bearing and suspension joint looseness, including tie rod ball joints. If the steering gear is securely mounted on the crossmember, the steering column universal joint and flex coupling are not loose or damaged and the front wheels cannot wobble independently, but steering wheel straight-ahead free play is over 3/8 inch, excessive lash is indicated between the rack and pinion.



DIAGNOSTIC PROCEDURES

WANDER (Continued)

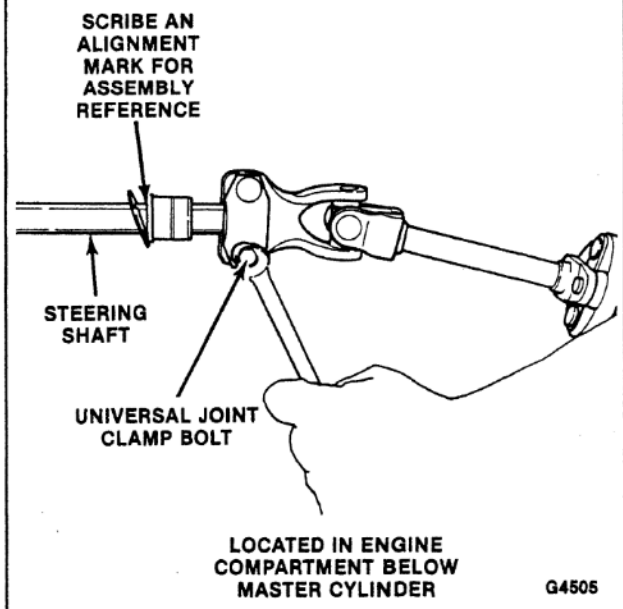
This can result from worn or damaged parts or insufficient rack yoke pressure. Disassemble the steering gear, inspect all components and adjust rack yoke pressure. If necessary, refer to Section 13-46 for steering gear repair procedures.



NOTE: The rack yoke preload adjustment is to be performed only as part of a steering gear overhaul.

POOR RETURNABILITY

If steering does not return freely to the straight-ahead position when the wheel is released following a turn, excessive friction or binding is present somewhere in the system. To isolate the problem, it is necessary to disconnect various parts of the system and check them independently. To check for steering column bind, mark the intermediate shaft universal joint clamp and the steering shaft to ensure correct reassembly, and remove the clamp bolt so that the clamp plate can be swung free, releasing the intermediate shaft assembly from the steering shaft. The steering wheel can now be turned independently and any binding or rubbing in the steering wheel and shaft assembly will be immediately apparent. If necessary, refer to Section 13-04 for steering column service procedures.

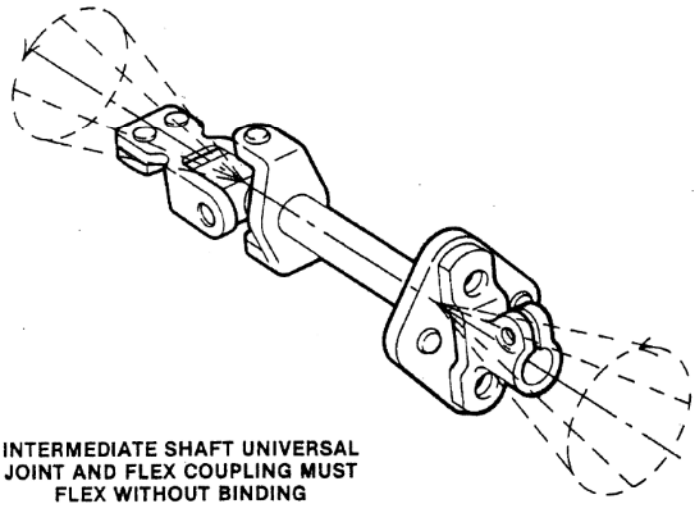


DIAGNOSTIC PROCEDURES

POOR RETURNABILITY (Continued)

Before reconnecting the intermediate shaft, remove the pinch bolt securing the flex coupling to the steering gear pinion shaft, and remove the intermediate shaft assembly.

Check the rotation action of the universal joint and flex coupling at their normal operating angles to be sure there are no tight or stiff spots to interfere with steering returnability.

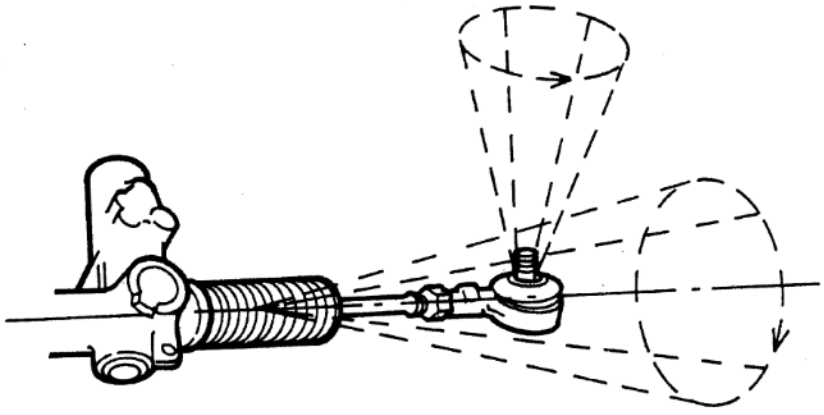


INTERMEDIATE SHAFT UNIVERSAL JOINT AND FLEX COUPLING MUST FLEX WITHOUT BINDING

G4670-A

While the steering gear is disconnected from the column, disconnect the tie rod ends from the wheel spindle supports and verify that the ball studs swivel freely. Also, flex the tie rods relative to the rack to be sure that the rack ball joints are not seized or binding.

NOTE: The procedure for disconnecting the tie rods from the spindles can be found in Section 13-46 in the tie rod removal and installation procedure.



TIE ROD END BALL STUD AND RACK BALL JOINT MUST ARTICULATE FREELY
NOTE: CHECK BOTH SIDES

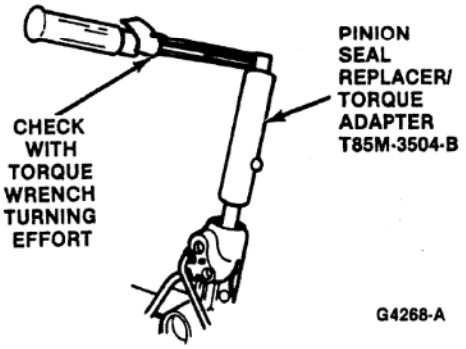
G4671-A

DIAGNOSTIC PROCEDURES

POOR RETURNABILITY (Continued)

To check for front suspension bind, turn the road wheels through their normal steering travel while the tie rods are disconnected, with the wheels on swivel plates and supporting the normal vehicle front end loading. Investigate any tight spots or side-to-side differences.

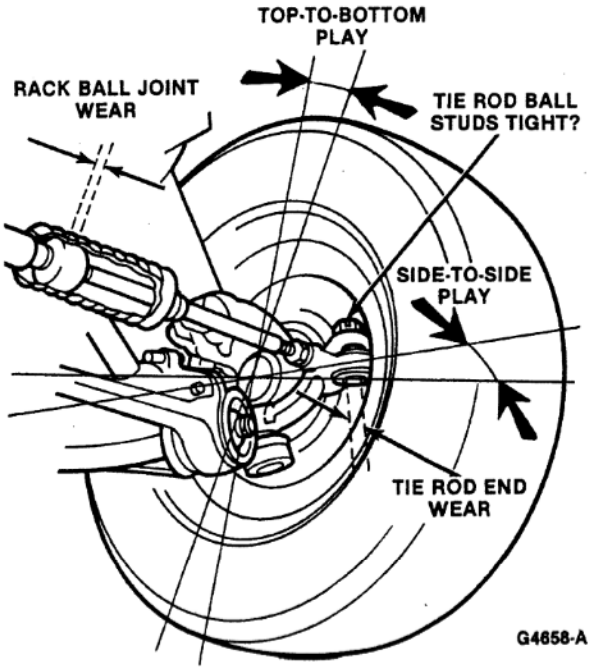
Finally, with the steering gear isolated from the steering column and road wheels, measure pinion shaft turning effort, using the Pinion Shaft Torque Adapter T85M-3504-B and a low-reading torque wrench. With the rack centered in the straight-ahead position, pinion turning effort should not exceed 1.7 N·m (15 lb-in.). If higher, the rack yoke preload is excessive or the rack is bent. Turn the pinion to one stop, then to the other to check for tight spots. Turning effort should increase slightly and uniformly as the rack moves away from the centered, straight-ahead position. If turning effort is erratic or excessive, the steering gear must be removed and repaired. If necessary, refer to Section 13-46 for steering gear service procedures.



NOISE

Steering system noise may be heard as rattle, chuckle or knocking, moan or whine, hiss, squeal, clicking or chattering. In noise diagnosis, it is important that the technician actually hear the noise, rather than relying on someone else's description.

Rattle, chuckle or knocking noise is often traceable to worn or loose steering system components, normally discovered in the inspection process. Loose or worn steering column parts, intermediate shaft universal joint or flex coupling, worn tie rod ends or ball joints, loose steering gear mounting hardware, or loose or worn suspension bushings or components all can contribute to noise of this type.



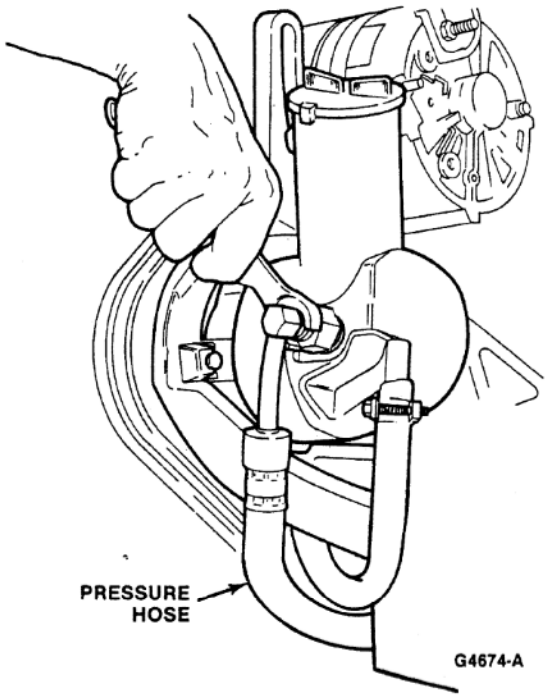
DIAGNOSTIC PROCEDURES

NOISE (Continued)

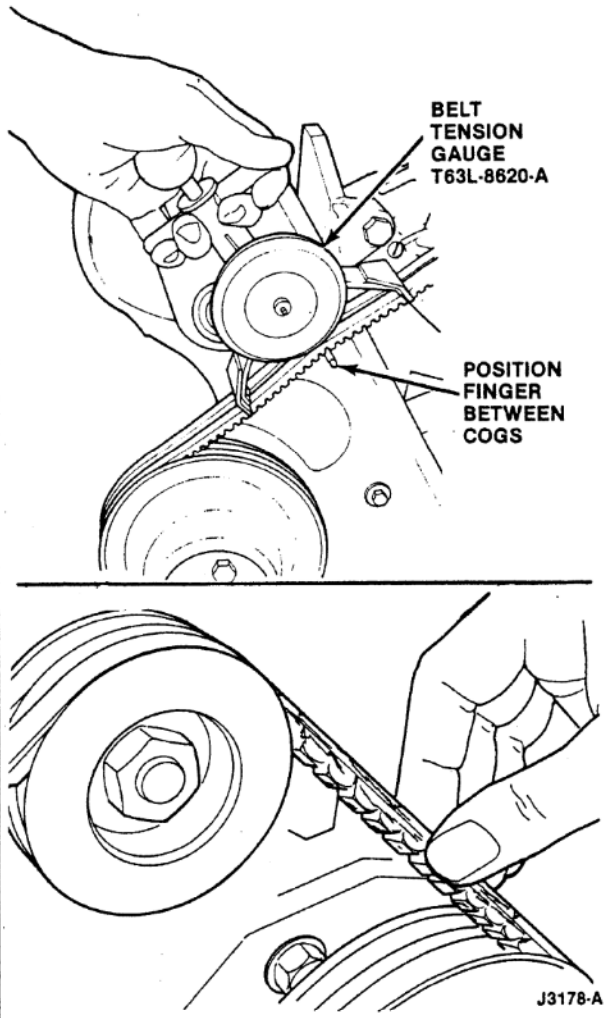
Also, wear or damage in steering gear components, such as a worn pinion bearing, loose bearing locknut or insufficient rack yoke pressure should be investigated. If necessary, refer to Section 13-46 for steering gear service procedures.* A loose pump pulley or pump mounting or misaligned pump support are also possible causes.

Moan or whine usually originates at the power steering pump and may be caused by low fluid level or aeration of the fluid. If air bubbles persist after repeated lock-to-lock cycling, purge the system as detailed elsewhere in this section. Moan or whine may also be caused by loose or misaligned pump mounting parts, or by grounding of the pressure hose against some part of the vehicle between pump and steering gear. Also, internal pump leakage caused by worn or damaged seals or other parts may be responsible. If necessary, refer to Section 13-51 for pump repair procedures.

***NOTE:** If equipped with a ZF steering gear, replace with a service gear assembly.



Full-lock squeal, heard in parking maneuvers, usually means loose or worn pump drive belts. If necessary, refer to Section 27-02 for belt tensioning procedures. If squeal persists with belts correctly tensioned, the pump relief pressure may be excessive. If necessary, refer to the relief pressure test procedure in this section.

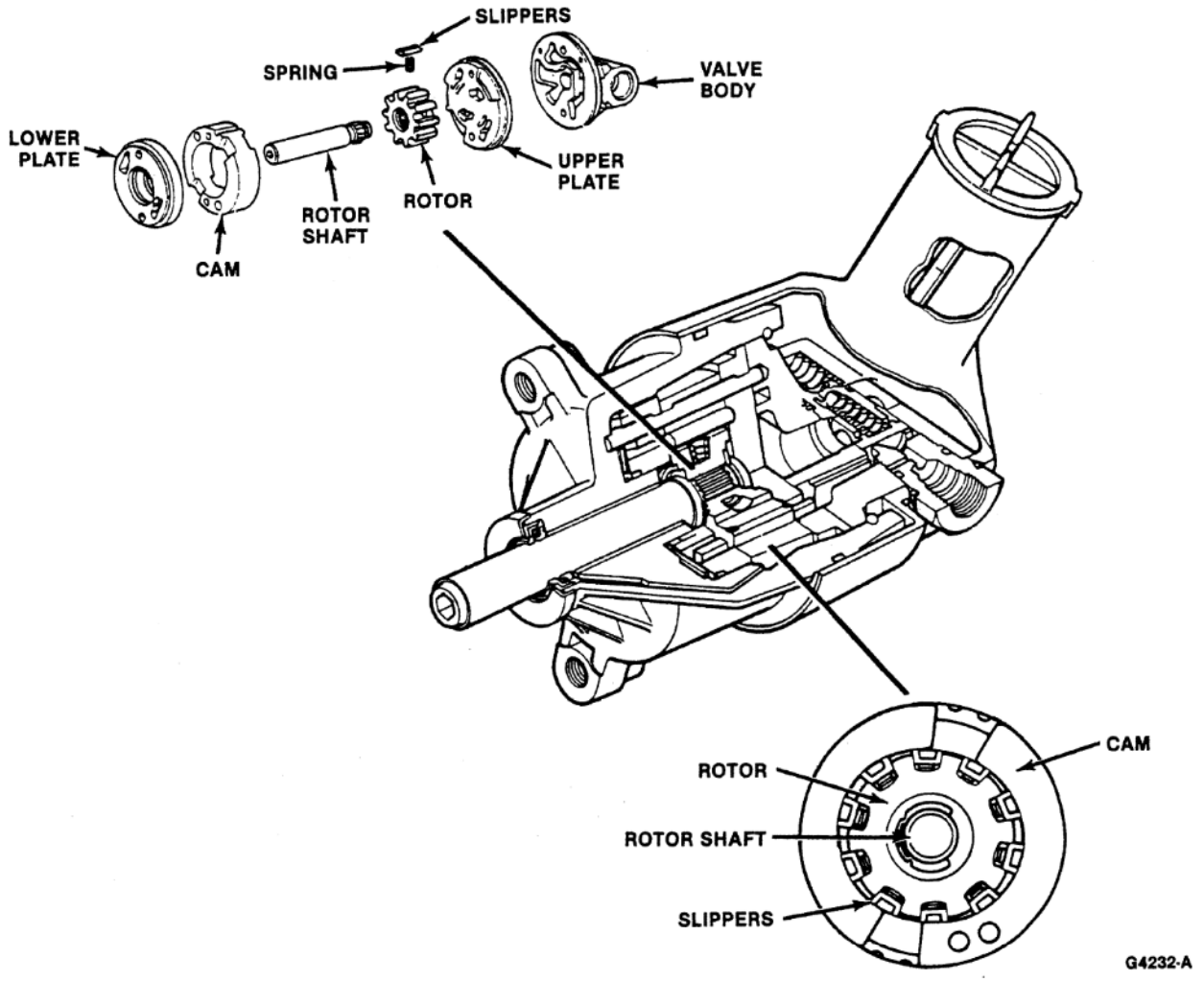


DIAGNOSTIC PROCEDURES

NOISE (Continued)

Steering gear hiss is part of normal power steering gear operation, but if objectionably loud inside the vehicle, it may be transmitting through misaligned or grounded steering column components.

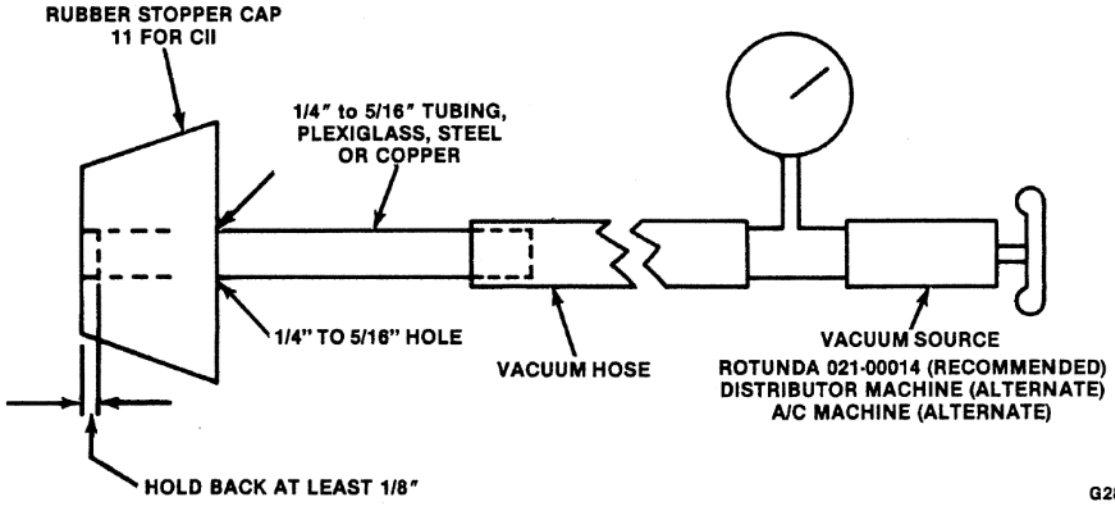
Clicking or chattering noise from the pump during parking maneuvers indicates internal pump problems, such as broken slipper springs, excessive slipper length, excessively worn rotor or cam. If necessary, refer to Section 13-51 for pump repair procedures.



DIAGNOSTIC PROCEDURES

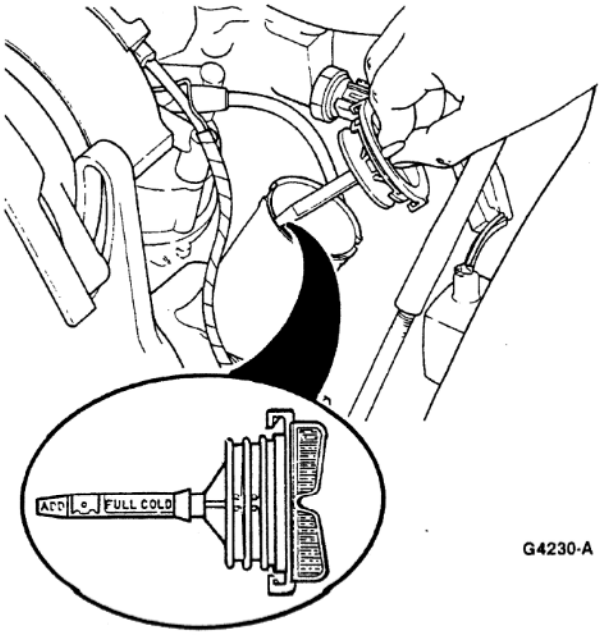
PURGING THE POWER STEERING SYSTEM OF AIR

When air entrained in the power steering fluid causes a persistent whine or moaning noise and can't be removed by normal steering gear cycling, vacuum purging becomes necessary. Assemble an airtight adapter for the reservoir filler neck, using a suitable rubber stopper cap and a piece of tight-fitting tubing. Connect the adapter to a suitable vacuum source, such as Rotunda 021-00014, or equivalent, with a length of vacuum hose.



Fill the pump reservoir to the COLD full mark on the dipstick, with Motorcraft Type F Automatic Transmission Fluid ESW-M2C33-F, or equivalent.

Raise the front wheels off the floor, disconnect the ignition coil and crank the engine without turning the steering wheel. Recheck the fluid level and refill to the COLD full mark, if necessary. Then, crank the engine with the starter while cycling the steering lock-to-lock. Recheck the fluid level and add fluid, if necessary.



DIAGNOSTIC PROCEDURES

PURGING THE POWER STEERING SYSTEM OF AIR (Continued)

Plug the vacuum adapter tightly into the reservoir filler neck, connect the ignition coil, and start the engine. Apply a vacuum of 15 inches Hg (51 kPa) for at least three minutes with the engine idling, maintaining the vacuum as air is released.

Release the vacuum, remove the adapter, and refill the reservoir to the COLD full level. Reinstall the vacuum adapter and apply a 15-inch Hg (51-kPa) vacuum to the reservoir with the engine idling. Maintain the vacuum while cycling the steering from lock to lock every 30 seconds for about five minutes. **Do not hold the steering at full lock.**

Release the vacuum, remove the adapter, and add fluid, if necessary. Install the dipstick, cycle the steering with the engine idling, and check all connections for leaks. Normally, the foregoing procedure will have removed the air from the system, but in cases of severe aeration, it may have to be repeated.

SECTION 13-04 STEERING COLUMN

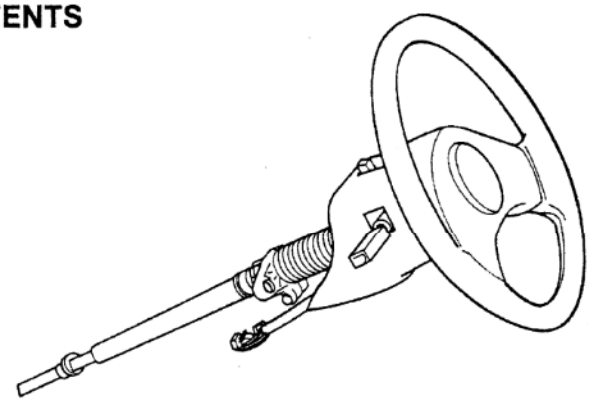
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DISASSEMBLY AND ASSEMBLY
- Tube/Switch Assembly 13



G4476-A

DESCRIPTION

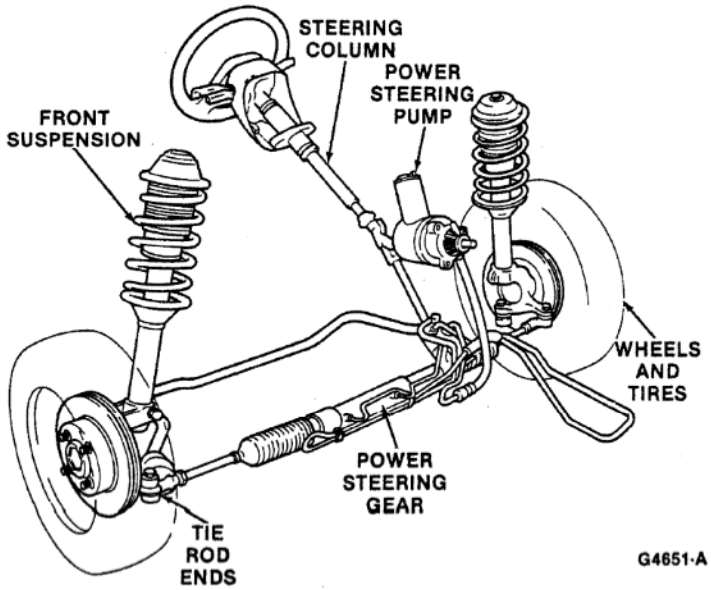
The steering column assembly consists of a shaft tube, upper and lower bearings, mounting brackets, ignition lock and two switch assemblies.

At its lower end, the steering shaft is connected to the intermediate steering shaft. The upper end of the steering shaft has a tapered hexagon and is threaded in order to securely attach the steering wheel.

Fitted into the lower end of the steering column tube is a ball bearing assembly. The upper bearing assembly fits into the ignition lock body which is a tight push-on fit to the steering column tube.

Both switch assemblies are mounted on the cast body of the ignition lock.

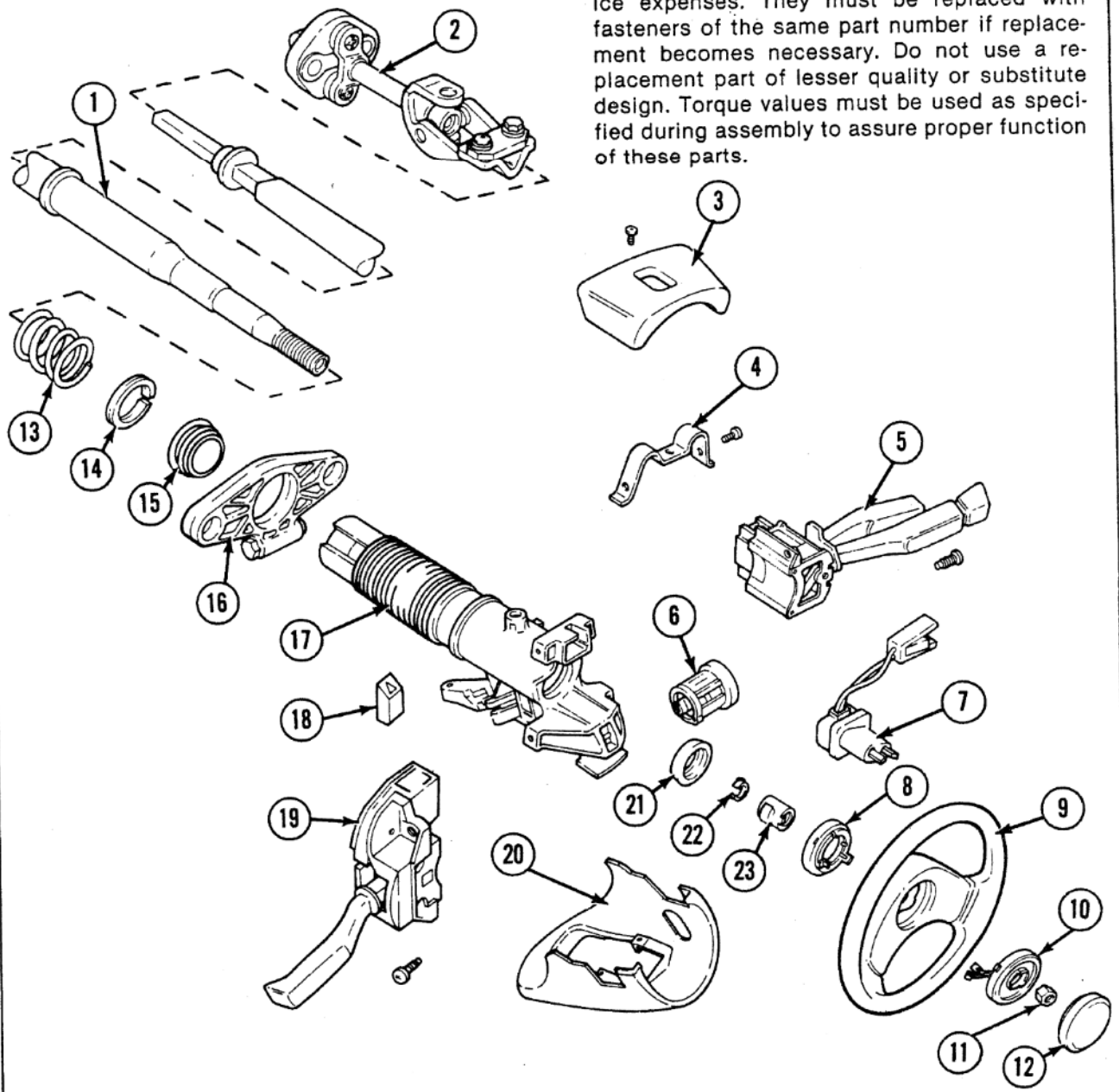
The steering column assembly is attached to the body bracket by a diecast bracket, which is clamped to the lower end of the tube.



G4651-A

DESCRIPTION

NOTE: All fasteners are important parts in that they could affect the performance of vital parts and systems, and/or could result in major service expenses. They must be replaced with fasteners of the same part number if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during assembly to assure proper function of these parts.



1. STEERING COLUMN SHAFT (3675)
2. INTERMEDIATE SHAFT (3B676)
3. UPPER TRIM COVER (3530)
4. TRIM BRACKET (3K517)
5. HEADLIGHT/WIPER SW. (11654)
6. LOCK CYLINDER (3675)
7. HORN CONTACTS (13A821)
8. HORN RING (13A823)
9. STEERING WHEEL (3600)
10. HORN SWITCH (3A515)
11. WHEEL ATTACHING NUT (822058)
12. HUB COVER (3A515)
13. PRELOAD SPRING (3520)
14. TOLERANCE RING (13318)
15. LOWER BEARING (3517)
16. MOUNTING BRACKET (3B743)
17. TUBE ASSEMBLY/IGNITION LOCK BODY (3L576)
18. HAZARD SW. BUTTON (13341)
19. TURN SIGNAL SW. (13341)
20. LOWER TRIM COVER (3533)
21. UPPER BEARING (3517)
22. TOLERANCE RING (13318)
23. CANCELLING CAM (13318)

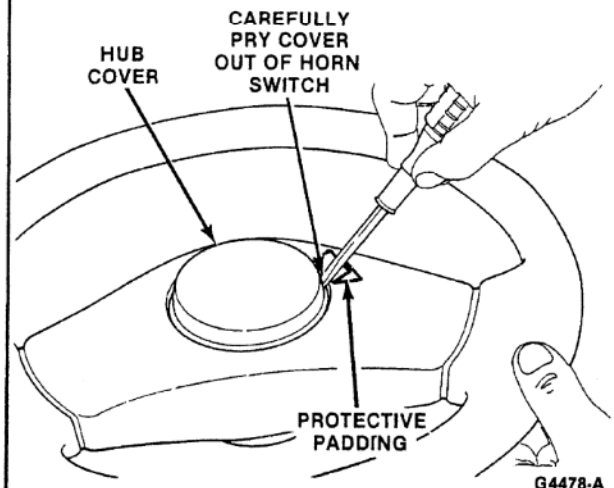
G4232-A

REMOVAL AND INSTALLATION

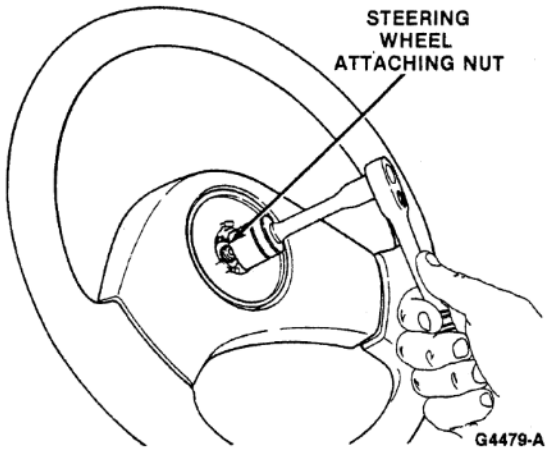
STEERING WHEEL

Removal

1. Disconnect the battery negative cable.
2. Center the steering wheel with the wheels in the straight-ahead position.
3. Remove the steering wheel center hub cover.



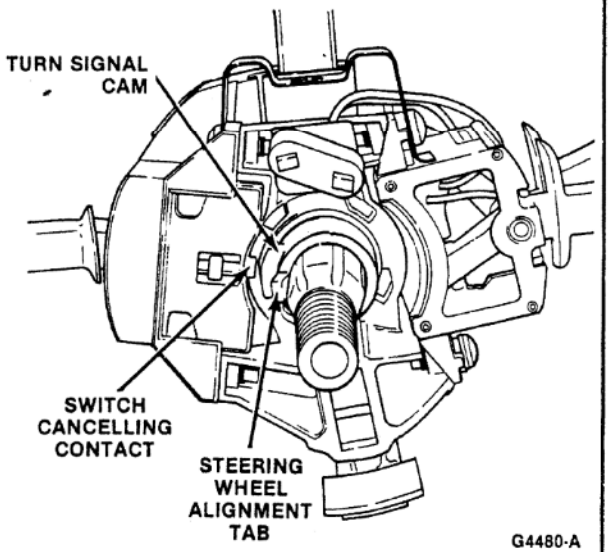
4. Loosen the steering wheel attaching nut.



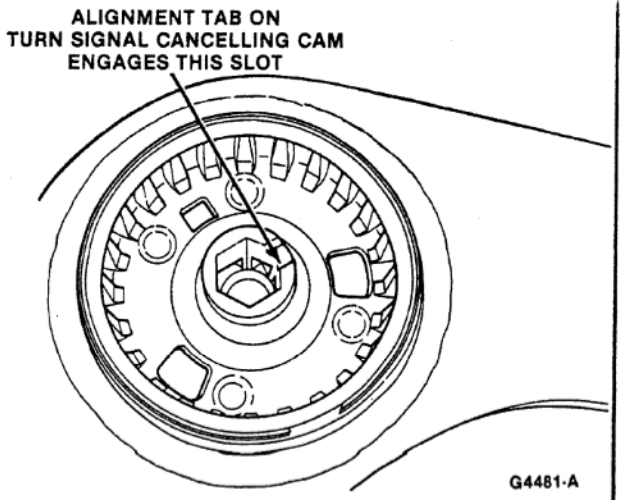
5. Turn the ignition key to the run position.
6. Pull the steering wheel straight up to release from the taper on the steering shaft.
7. Remove the attaching nut and the steering wheel.

Installation

1. Make sure the turn signal cam is aligned with the turn signal switch cancelling lever.



2. Install the steering wheel. Make sure the tab on the turn signal cancelling cam alignment tab engages the slot on the underside of the steering wheel hub.

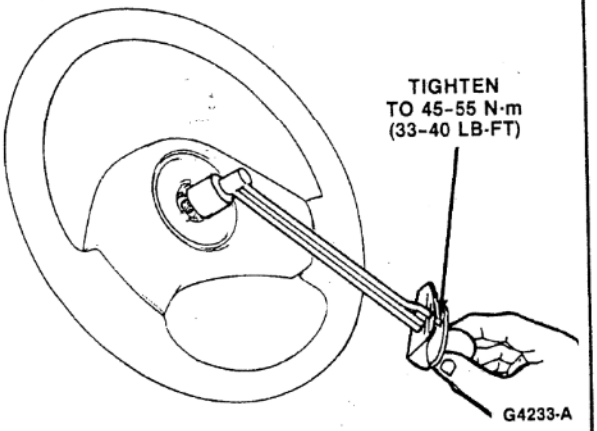


REMOVAL AND INSTALLATION

STEERING WHEEL

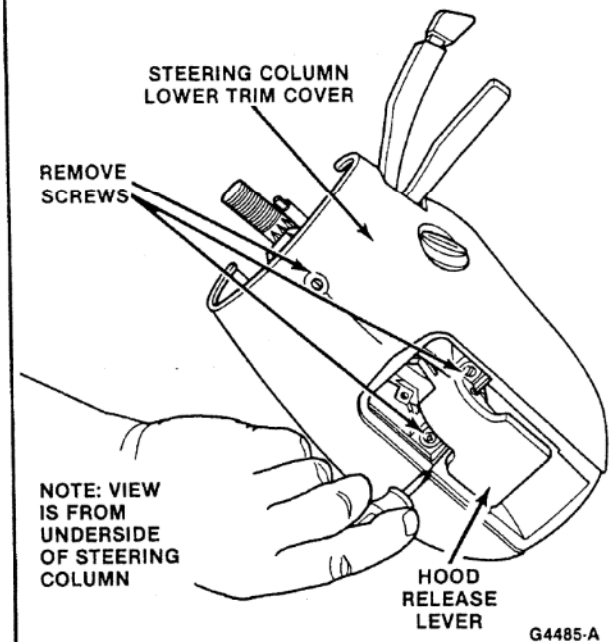
Installation (Continued)

3. Install the steering wheel attaching nut.
   Tighten the attaching nut to 45 to 55 N·m (33 to 40 lb-ft).



4. Remove the ignition key and check the steering wheel lock for proper operation.
5. Install the steering wheel center hub cover.
6. Connect the battery negative cable.

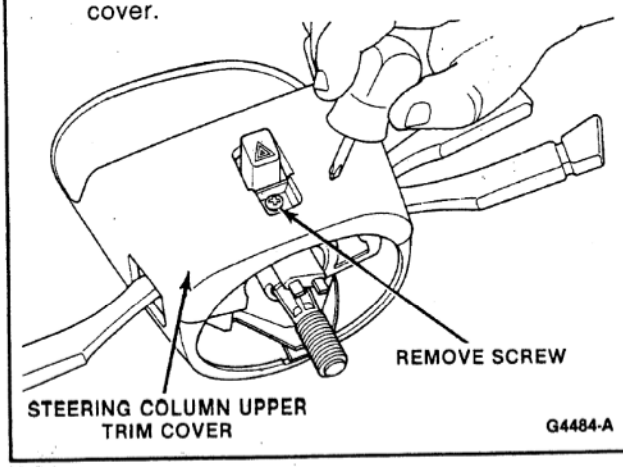
4. Remove the steering column lower trim cover.



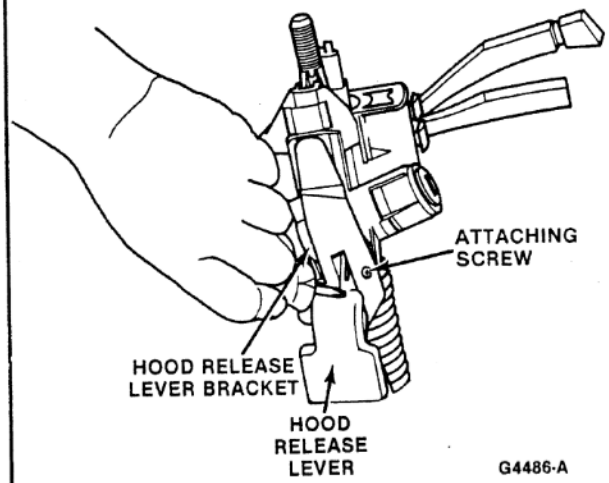
TUBE/SWITCH ASSEMBLY

Removal

1. Disconnect the battery negative cable.
2. Remove the steering wheel. If necessary, refer to the procedure in this section.
3. Remove the steering column upper trim cover.



5. Remove the hood release bracket attaching screw.

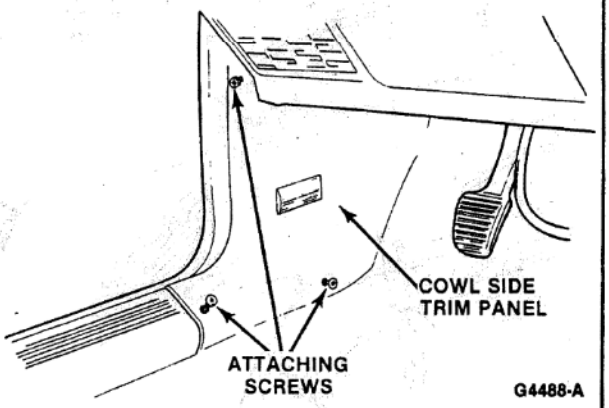


REMOVAL AND INSTALLATION

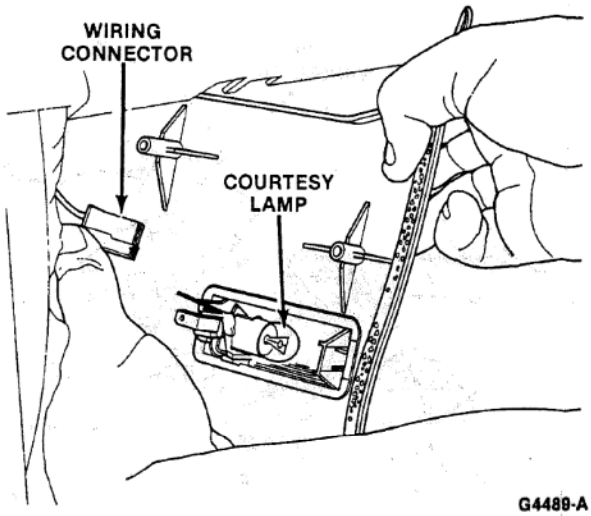
TUBE/SWITCH ASSEMBLY

Removal (Continued)

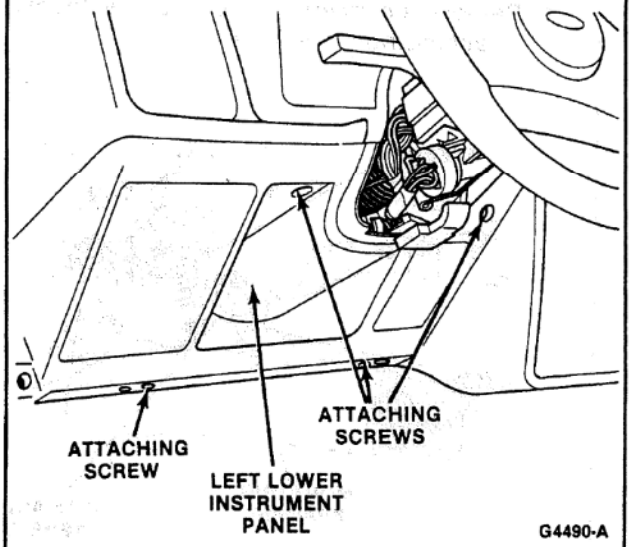
6. Remove the sound deadening panel located under the instrument panel.
7. Remove the cowl side trim panel attaching screws.



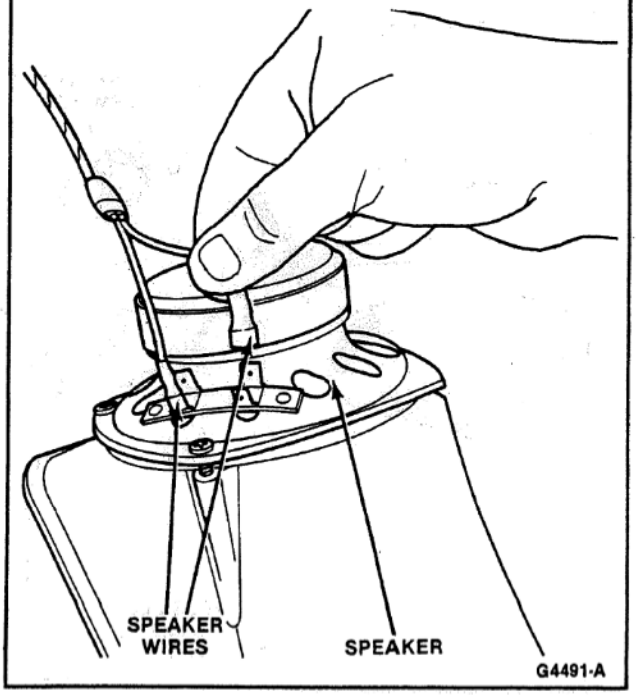
8. Pull the cowl side trim panel away from the body, disconnect the courtesy light wires and remove the panel.



9. Remove the left lower instrument panel attaching screws.



10. Lower the instrument panel, disconnect the radio speaker wires and remove the panel.

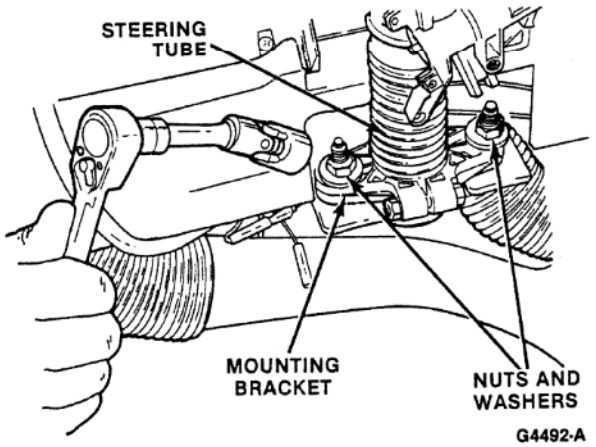


REMOVAL AND INSTALLATION

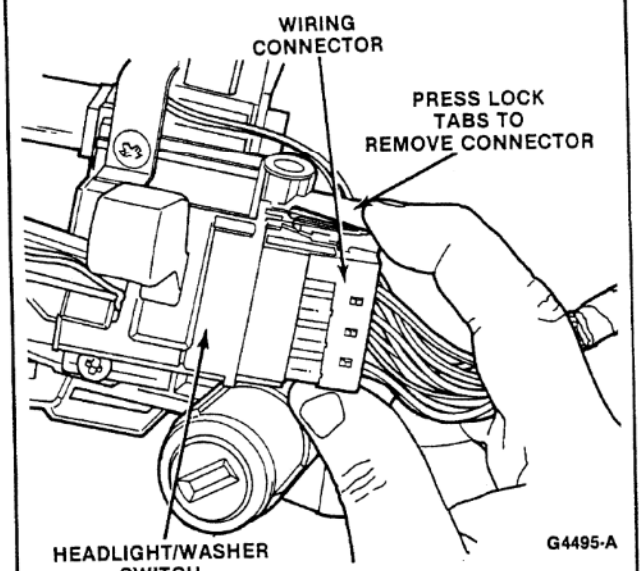
TUBE/SWITCH ASSEMBLY

Removal (Continued)

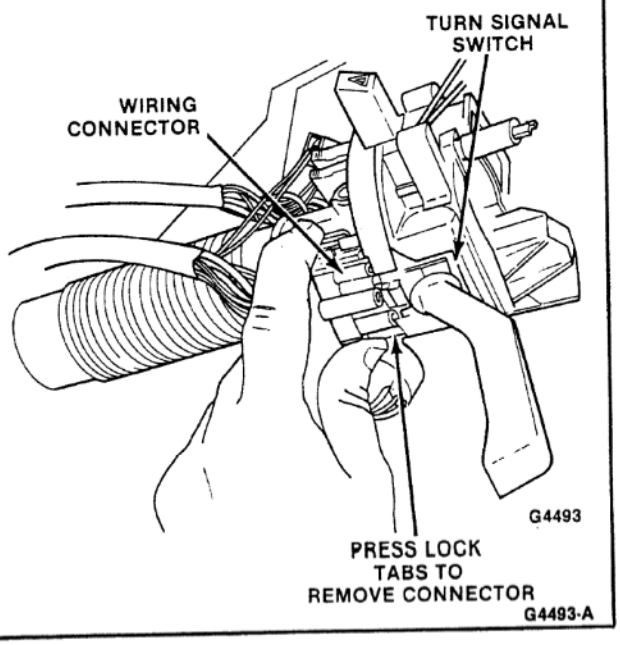
11. Remove the steering tube mounting bracket attaching nuts and washers.



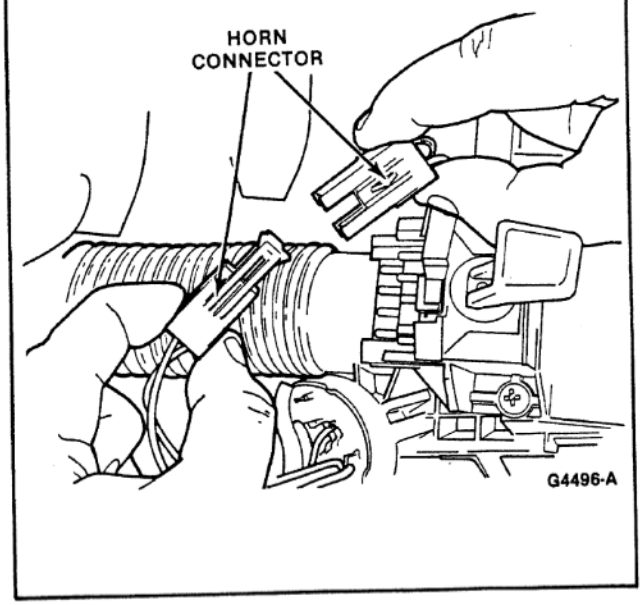
- Headlight
- Wiper/Washer



12. Disconnect the following switch wiring connectors:
    - Turn signal



- Horn

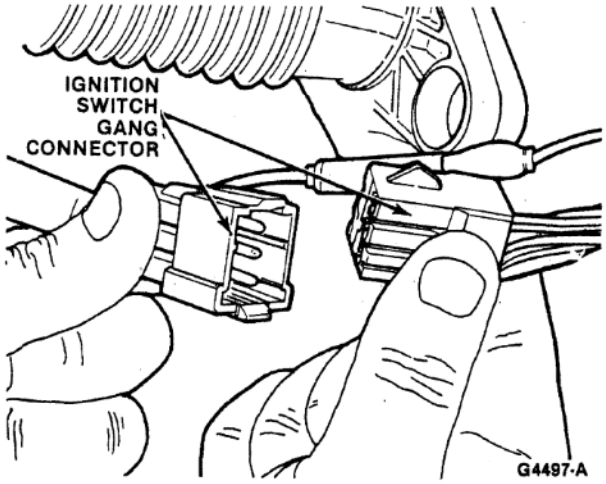


REMOVAL AND INSTALLATION

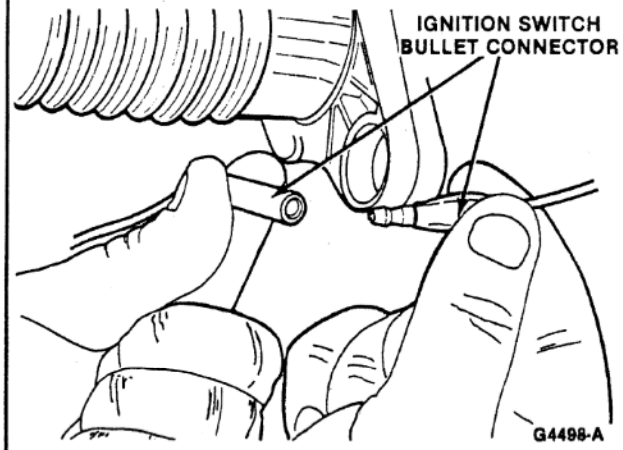
TUBE/SWITCH ASSEMBLY

Removal (Continued)

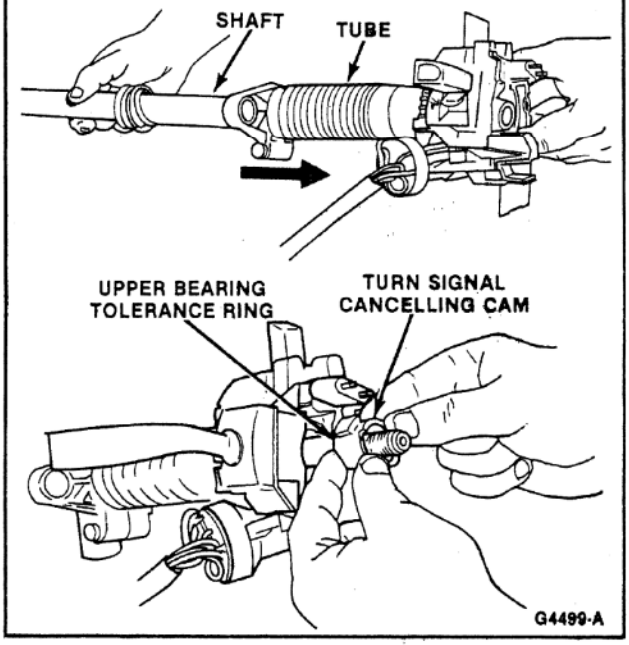
- Ignition switch gang



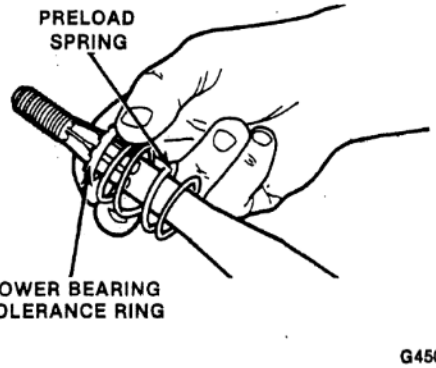
- Ignition switch bullet



13. Pull upward on the steering column tube to remove. As the tube/switch assembly clears the end of the shaft, remove the turn signal cancelling cam and upper bearing tolerance ring.



14. If necessary, remove the preload spring and lower bearing tolerance ring from the steering shaft.



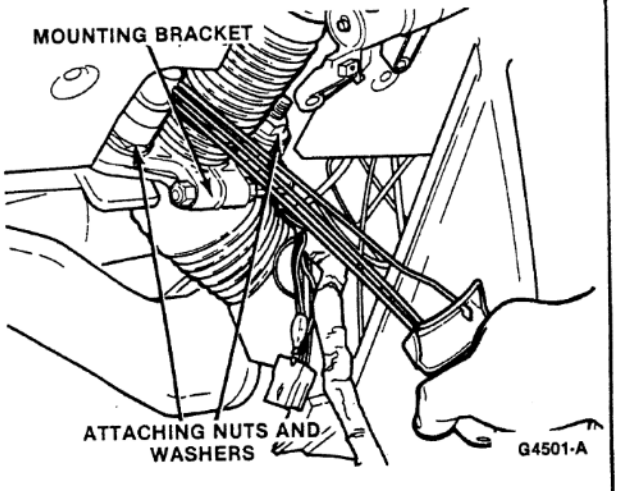
REMOVAL AND INSTALLATION

TUBE/SWITCH ASSEMBLY

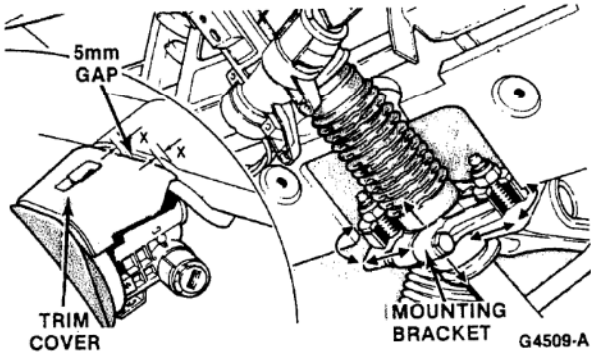
Installation

NOTE: If the steering column mounting bracket was removed or loosened for any reason, make sure the clamp bolt in the mounting bracket is loose before installing the tube/switch assembly.

1. If removed, install the preload spring and bearing retainer on the steering shaft.
2. Position the mounting bracket and tube/switch assembly over the steering shaft and mounting bracket studs.
3. Connect the following switch wiring connectors:
   - Ignition switch bullet
   - Ignition switch gang
   - Horn
   - Wiper/Washer
   - Headlight
   - Turn signal
4. Install the steering column mounting bracket attaching washers and nuts. Tighten the attaching nuts to 18 to 22 N·m (13 to 16 lb-ft).



5. If the steering column mounting bracket flange was loosened or removed, proceed as follows:
   a. Install the steering column upper trim panel.
   b. Push downward on the steering tube until a 5 mm (3/16 in.) gap exists between the upper trim panel and the instrument panel.



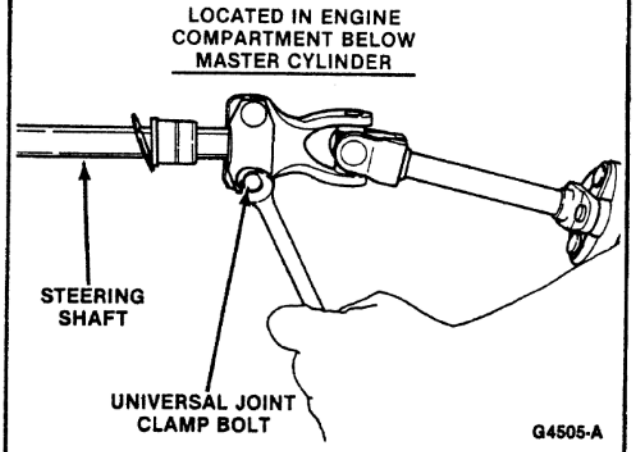
   c. While holding the steering tube in position, tighten the mounting bracket clamp bolt to 20 to 25 N·m (15 to 19 lb-ft).
   d. Remove the steering column upper trim panel.
6. Position the cowl side trim panel, connect the courtesy light wires and install the attaching screws.
7. Position the left lower instrument panel, connect the radio speaker wires and install the attaching screws.
8. Install the sound deadening panel under the instrument panel.
9. Position the hood release bracket and install the attaching screw.
10. Install the steering column lower trim cover.
11. Install the steering column upper trim cover.
12. Install the steering wheel. If necessary, refer to the procedure in this section.
13. Connect the battery negative cable.

REMOVAL AND INSTALLATION

STEERING COLUMN ASSEMBLY

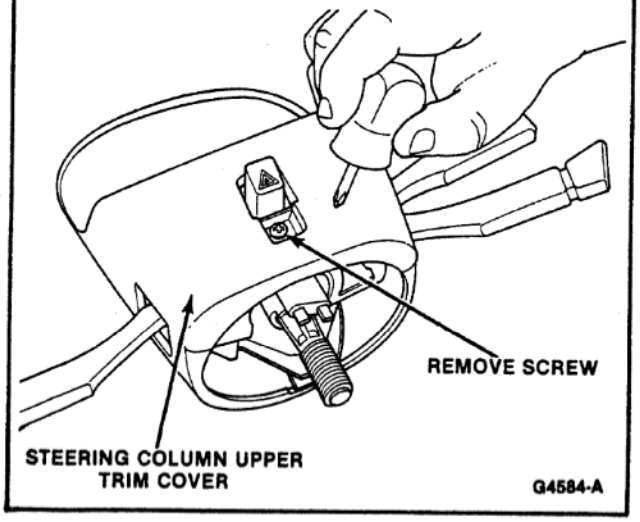
Removal

1. Disconnect the battery negative cable.
2. Raise the vehicle.
3. Loosen the steering shaft universal joint clamp bolt. Turn the steering wheel to bring the clamp bolt into an accessible position.

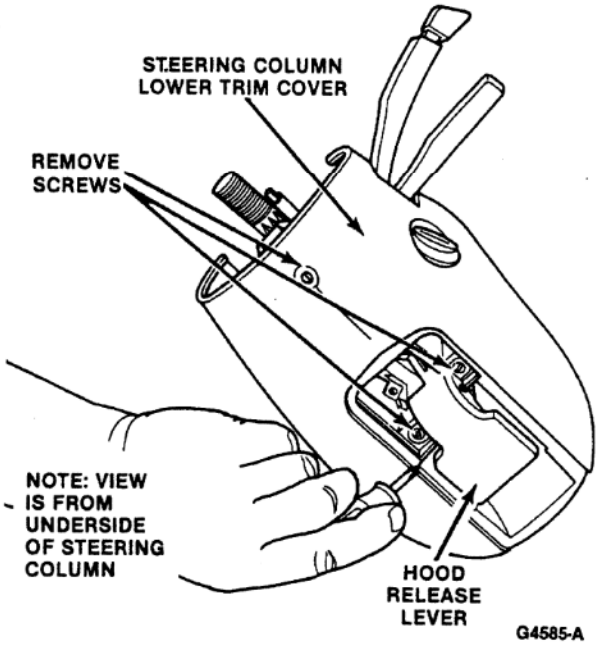


4. Center the steering wheel with the wheels in the straight-ahead position.
5. Lower the vehicle.

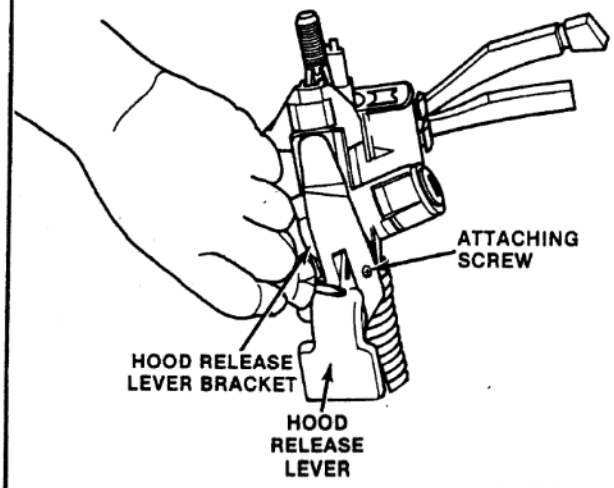
6. Remove the steering column upper trim cover.



7. Remove the steering column lower trim cover.



8. Remove the hood release bracket attaching screw.

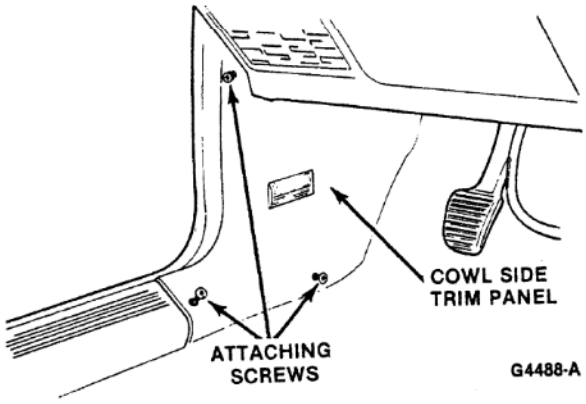


REMOVAL AND INSTALLATION

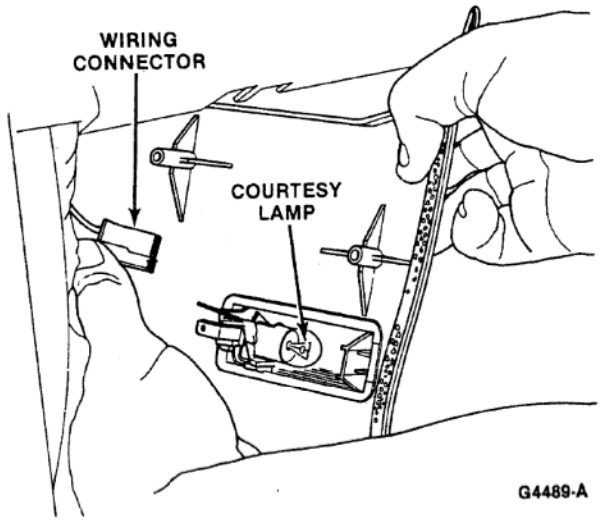
STEERING COLUMN ASSEMBLY

Removal (Continued)

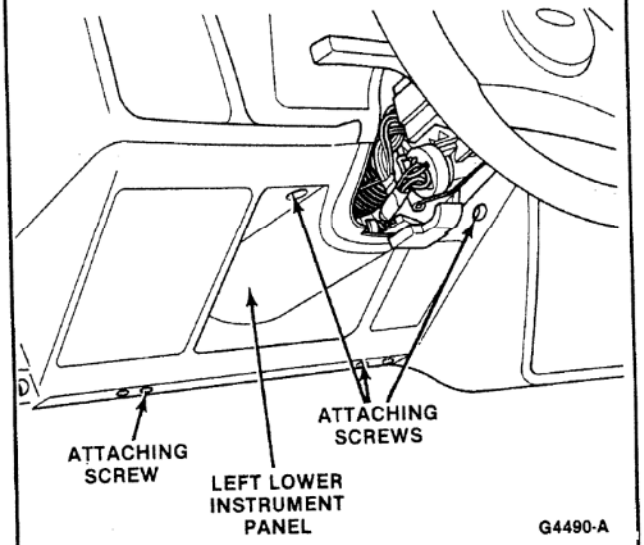
9. Remove the sound deadening panel located under the instrument panel.
10. Remove the cowl side trim panel attaching screws.



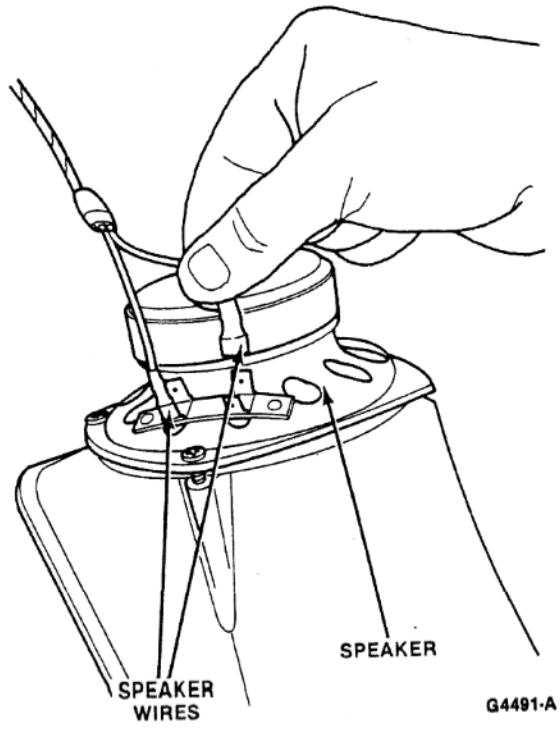
11. Pull the cowl side trim panel away from the body, disconnect the courtesy light wires and remove the panel.



12. Remove the left lower instrument panel attaching screws.



13. Lower the instrument panel, disconnect the radio speaker wires and remove the panel.

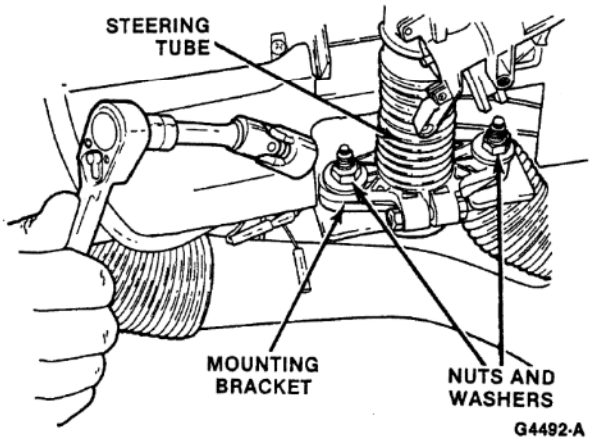


REMOVAL AND INSTALLATION

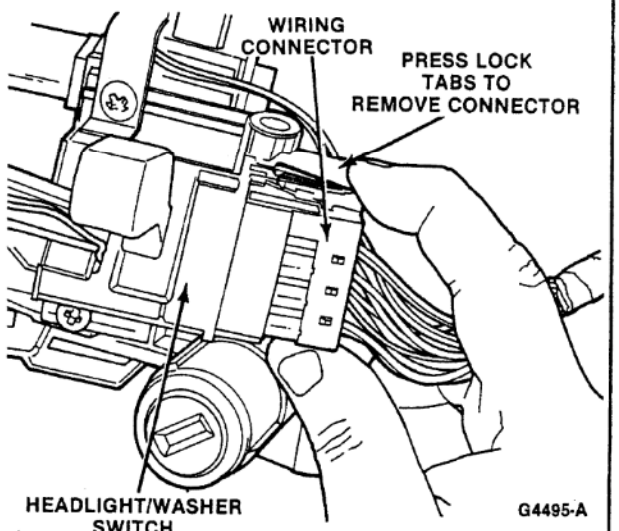
STEERING COLUMN ASSEMBLY

Removal (Continued)

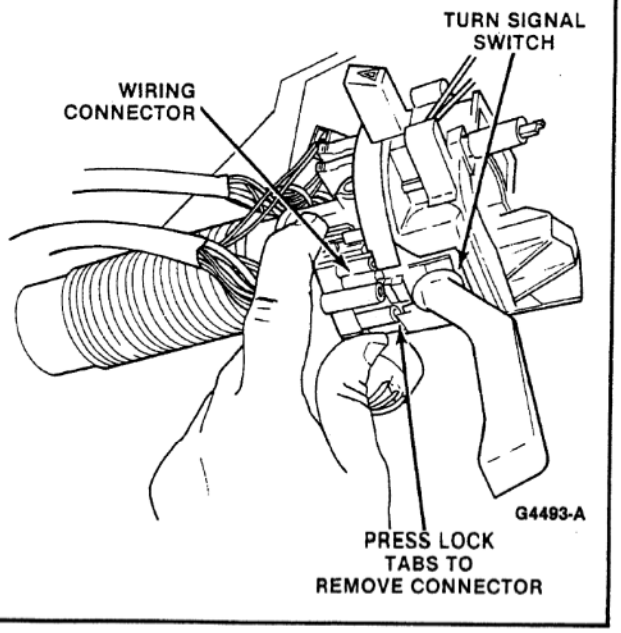
14. Remove the steering column mounting bracket attaching nuts and washers.



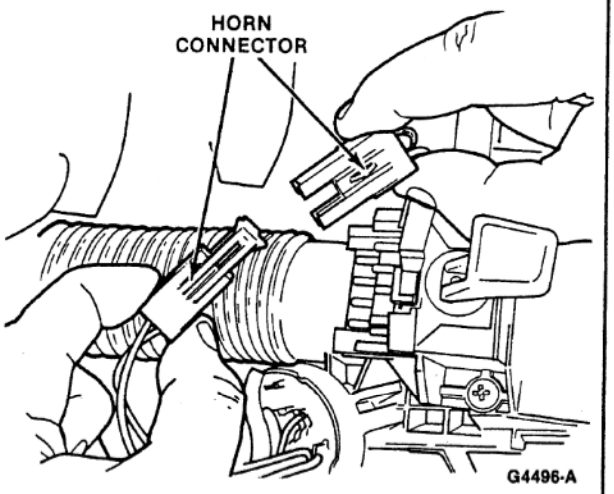
- Headlight
- Wiper/Washer



15. Disconnect the following switch wiring connectors.
    - Turn signal



- Horn

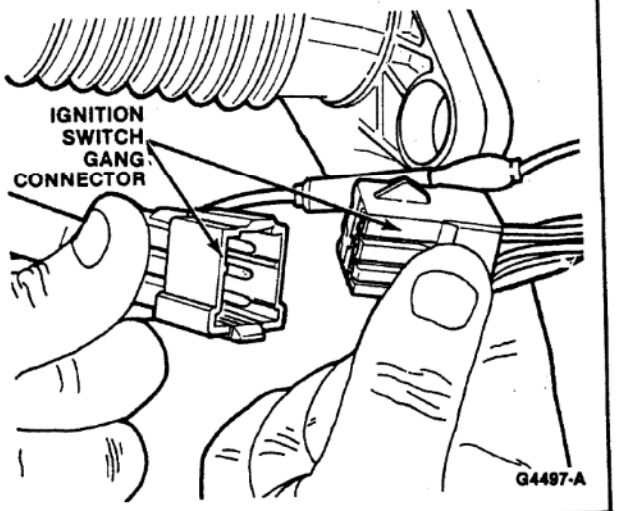


REMOVAL AND INSTALLATION

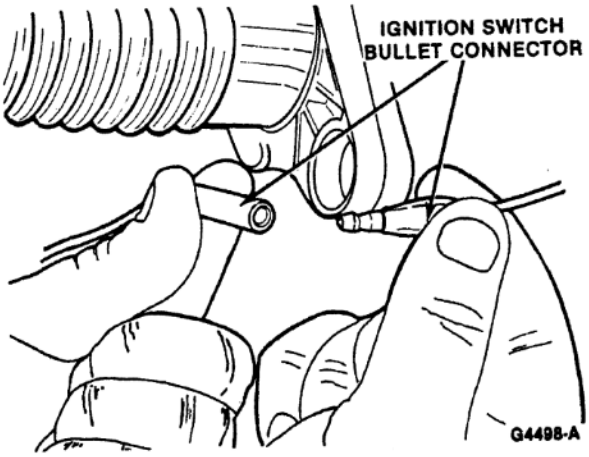
STEERING COLUMN ASSEMBLY

Removal (Continued)

- Ignition switch gang



- Ignition switch bullet.



16. Pull upward on the steering wheel to lift the mounting bracket clear of the mounting studs and to disengage the steering shaft from the universal joint clamp.

17. Remove the steering column assembly.

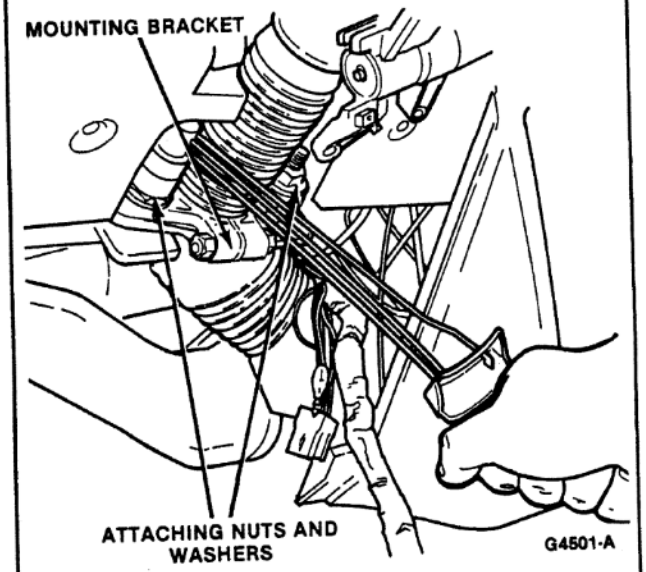
Installation

1. Install the steering column assembly.

   As the steering column is installed, center the steering wheel, raise the vehicle and have a helper align the steering shaft with the universal joint clamp.

2. Connect the following switch wiring connectors:
   - Ignition switch bullet
   - Ignition switch gang
   - Horn
   - Wiper/Washer
   - Headlight
   - Turn signal

3. Install the steering column mounting bracket attaching washers and nuts. Tighten the attaching nuts to 18 to 22 N·m (13 to 16 lb-ft).



4. Position the cowl side trim panel, connect the courtesy light wires and install the attaching screws.

5. Position the left lower instrument panel, connect the radio speaker wires and install the attaching screws.

REMOVAL AND INSTALLATION

STEERING COLUMN ASSEMBLY

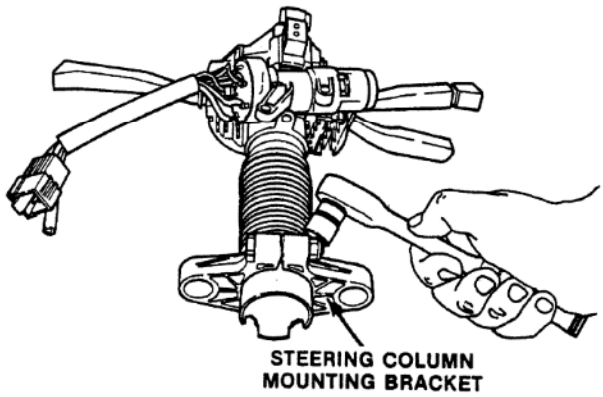
Installation (Continued)

6. Install the sound deadening panel under the instrument panel.
7. Position the hood release bracket and install the attaching screw.
8. Install the steering column lower trim panel.
9. Install the steering column upper trim cover.
10. Raise the vehicle.
11. Tighten the steering shaft universal joint clamp bolt.

    Tighten the bolt to 20 to 25 N·m (14 to 19 lb-ft).

12. Lower the vehicle and connect the battery negative cable.

2. Remove the steering column mounting bracket.

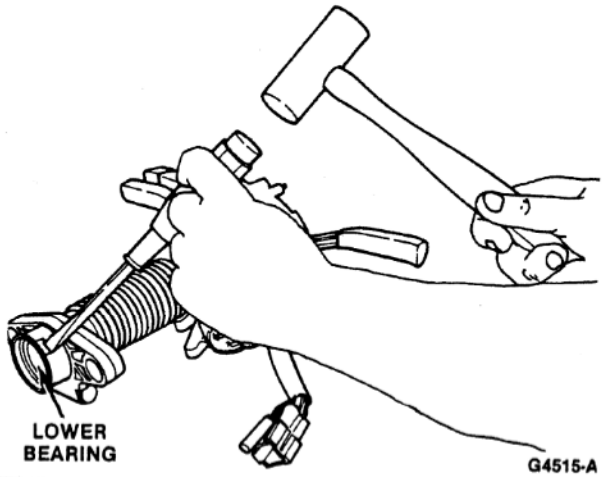


DISASSEMBLY AND ASSEMBLY

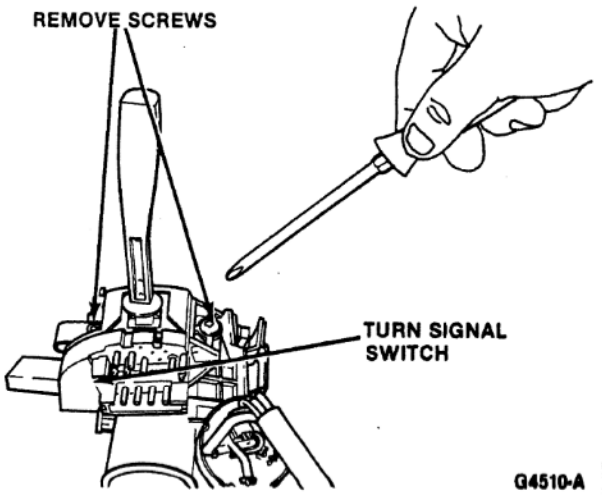
TUBE/SWITCH ASSEMBLY

Disassembly

1. Remove the lower bearing.



3. Remove the turn signal switch.

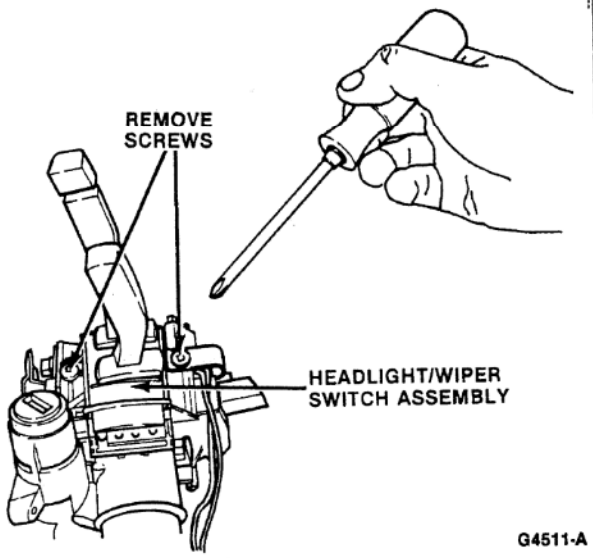


DISASSEMBLY AND ASSEMBLY

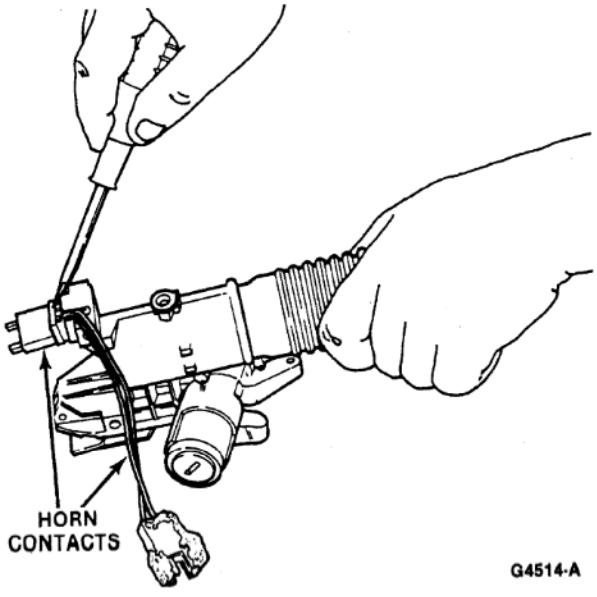
TUBE/SWITCH ASSEMBLY

Disassembly (Continued)

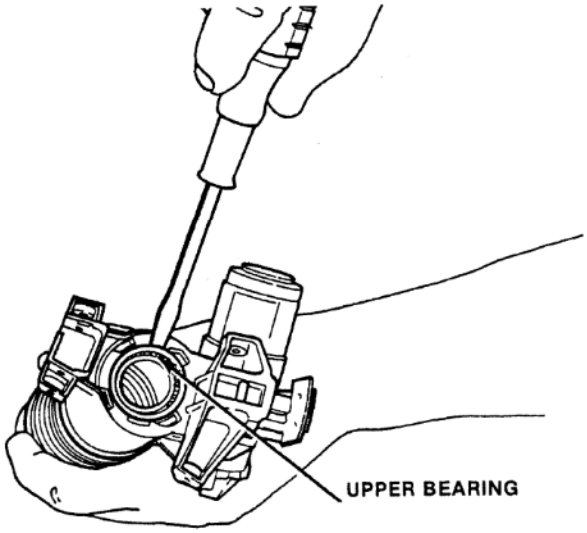
4. Remove the headlight/wiper switch assembly.



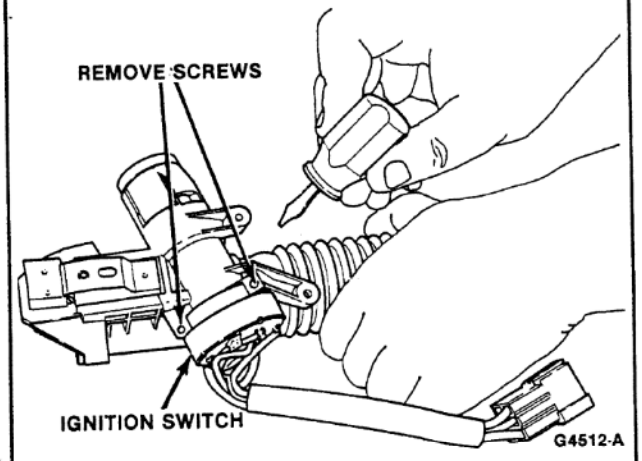
5. Remove the horn contacts.



6. Remove the upper bearing.



7. Remove the ignition switch.

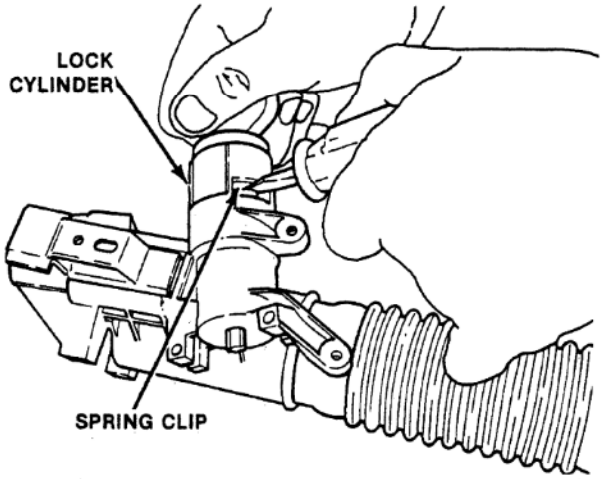


DISASSEMBLY AND ASSEMBLY

TUBE/SWITCH ASSEMBLY

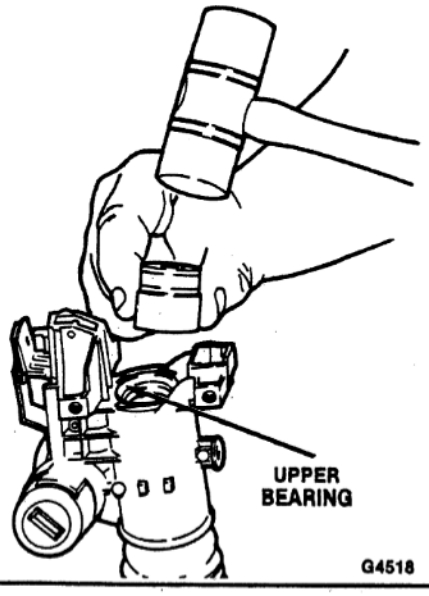
Disassembly (Continued)

8. Insert the ignition key and turn to position "I". Depress the lock cylinder spring clip and pull the lock cylinder out of the housing.

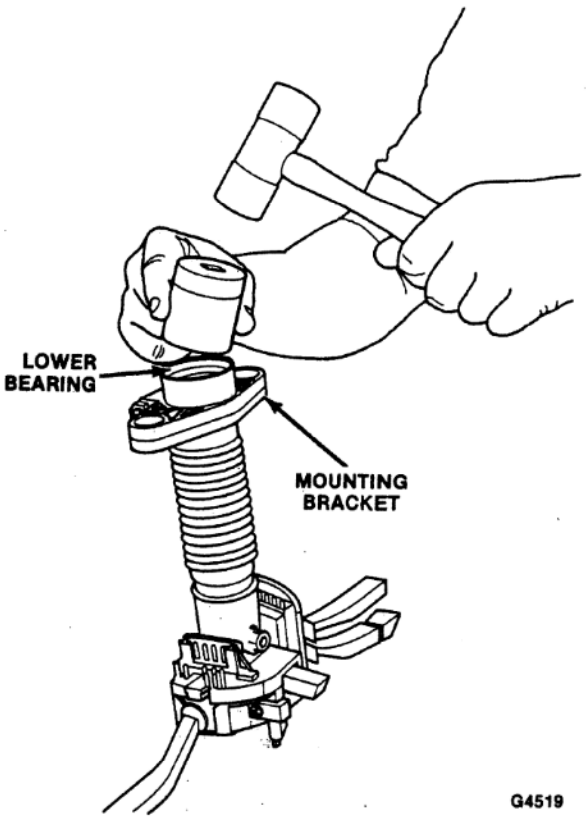


Assembly

1. Insert the ignition key in the lock cylinder and turn to the "I" position. Install the lock cylinder in the housing and remove the key.
2. Install the upper bearing using a socket. Make sure the tolerance ring is installed with the bearing.



3. Install the horn contacts.
4. Install the ignition switch.
5. Install the headlight/wiper switch assembly.
6. Install the turn signal switch.
7. Install the steering column mounting bracket. Do not tighten the pinch bolt.
8. Install the lower bearing using a socket.



SECTION 13-46 Power Steering Gear

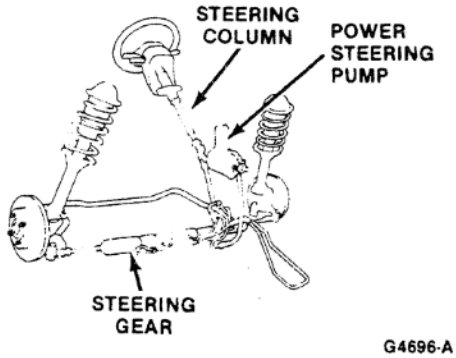
SUBJECT	PAGE
ADJUSTMENTS	
Rack Yoke Preload	13-46-3
DESCRIPTION	
Power Steering Gear Disassembled View	13-46-2
DISASSEMBLY AND ASSEMBLY	
Power Steering Gear	13-46-11

SUBJECT	PAGE
REMOVAL AND INSTALLATION	
Dust Boot	13-46-5
Rack Mounting Bushing	13-46-10
Steering Gear	13-46-6
Tie Rod Ball Joints	13-46-9
Tie Rod End	13-46-4

DESCRIPTION

The 1985 XR4Ti is equipped with a TRW Cam Gear power-assisted rack-and-pinion steering gear, in which the rack, in addition to connecting the front-wheel tie ends, is also a double-acting hydraulic cylinder. Power assist is provided by an open-center hydraulic system which supplies pressure equally to both ends of the rack cylinder, maintaining a balanced condition until driver input, through the steering wheel, tells the system a turn is called for. Then the pressure supplied to one end of the rack cylinder is reduced, and system pressure on the other end assists the pinion in moving the rack until steering wheel input indicates the driver's wishes have been satisfied.

NOTE: Some models may be equipped with a "ZF" power steering gear. Refer to Section 13-48 for "ZF" Power Steering Gear Service.



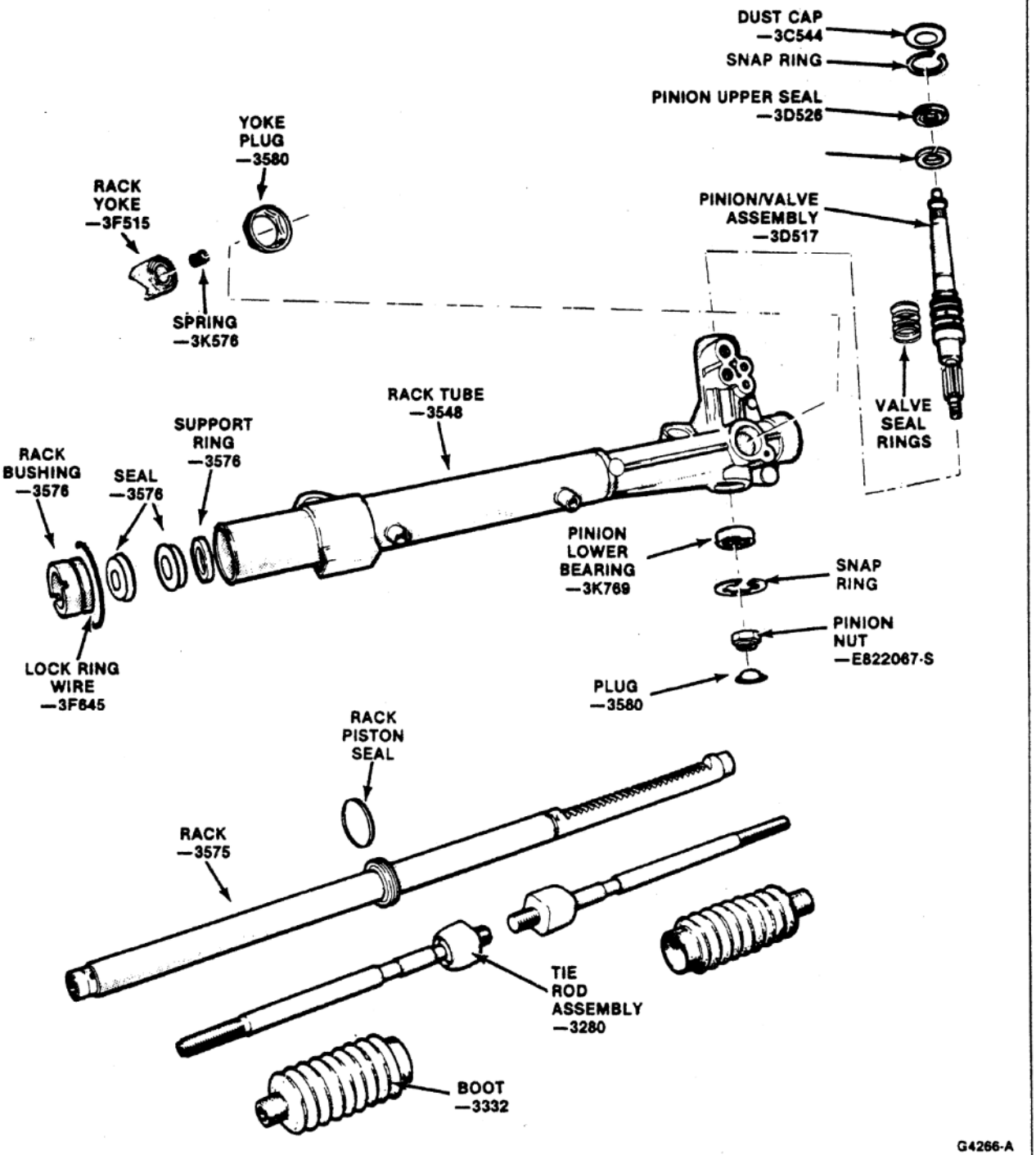
The hydraulic pressure is generated by a belt-driven pump mounted on the front of the engine. Fluid supply and return lines connect the pump to the control valving which is part of the steering gear. The control valve action results from rotary relative motion between the input shaft, connected to the steering column, and the pinion, in mesh with the rack. A torsion bar in the input shaft and pinion assembly centers the valve to supply balanced pressure to the rack cylinder when the steering wheel is not calling for a change of direction. When the wheel is turned, the torsion bar permits the pinion to lag behind the motion of the input shaft, shifting the valve to an unbalanced condition which in turn unbalances the pressures acting on the rack piston. When the rack has moved to the desired position, indicated by pinion (and steering wheel) position, the torsion bar restores the valving to the centered, balanced condition and power assist stops.

The action of the system is reversible, in that the self-centering or "caster" effect of the front-wheel geometry will actuate the valving through the pinion when the steering wheel is released.

In effect, the return to straight-ahead is also power assisted for desirable steering "feel."

DESCRIPTION (Continued)

Power Steering Gear Disassembled View



ADJUSTMENTS

RACK YOKE PRELOAD

SPECIAL SERVICE TOOLS REQUIRED:

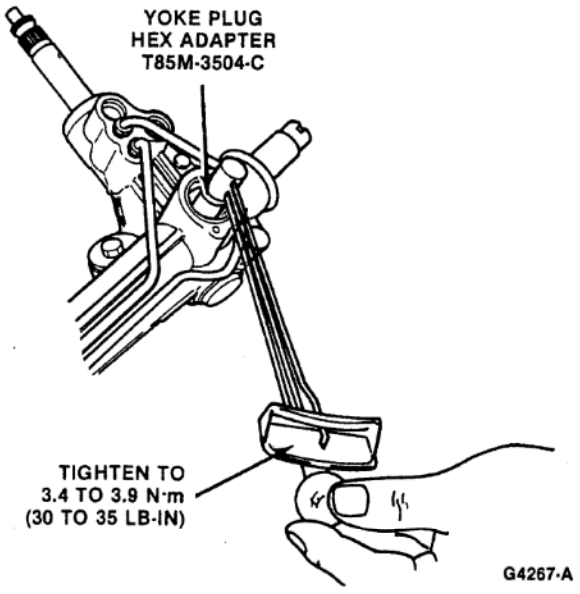
Yoke Plug Hex Adapter T85M-3504-C

Pinion Seal Replacer/Torque T85M-3504-B

NOTE: The rack yoke preload adjustment is not a service adjustment. It is to be done only as part of a complete overhaul of the steering gear.

1. Position the rack in the straight-ahead position and remove the yoke plug using Yoke Plug Hex Adapter T85M-3504-C, or equivalent.
2. Apply Loctite Activator N(764), or equivalent, on the yoke plug threads and install in the steering gear.
3. Using Yoke Plug Hex Adapter T85M-3504-C, tighten the plug to a torque of 3.4 to 3.9 N·m (30 to 35 lb-in.).
4. Install Pinion Shaft Seal Replacer/Torque Adapter on the pinion shaft. Position the tool so the lock screws engage the splines on the pinion shaft.

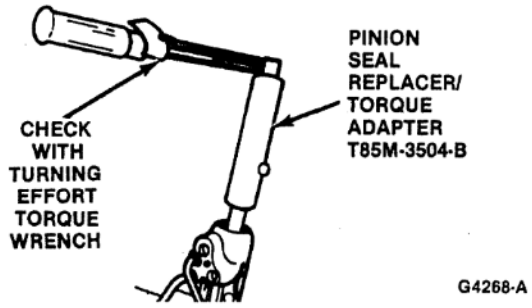
   Using the tool turn the pinion in one direction and then in the opposite direction until the rack has moved twice from stop-to-stop.



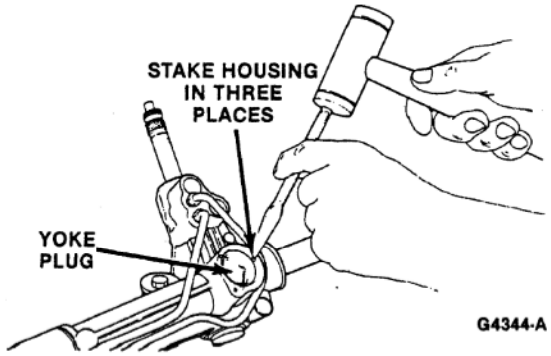
5. Return the rack to its straight-ahead position.
6. Check the yoke plug torque. If necessary, tighten the cover again to 3.4 to 3.9 N·m (30 to 35 lb-in.).
7. Check the pinion shaft turning effort, using the Pinion Shaft Torque Adapter T85M-3504-B and an inch-pound torque wrench. At this point in the procedure, the reading should not be less than 1.35 N·m (12 lb-in.). If it is less than this minimum, repeat Step 6.

NOTE: The rack cylinder should be in the horizontal position when checking pinion torque to prevent rack weight from affecting the reading.

8. When pinion shaft rotation torque meets the specification described in Step 7, back off the yoke plug 22° to 27°.
9. Check pinion shaft rotation again. Now, it should not exceed 1.7 N·m (15 lb-in.).
10. If torque exceeds the maximum specified in Step 9, the yoke cover may be backed off a distance not to exceed 5°.



11. Apply Loctite 290 penetrating grade anerobic sealant, or equivalent, on the yoke cover threads.
12. Stake the steering gear housing in three places around the yoke plug. Do not use the original staking positions.



13. Install the steering gear. If necessary, refer to the procedure in this section.

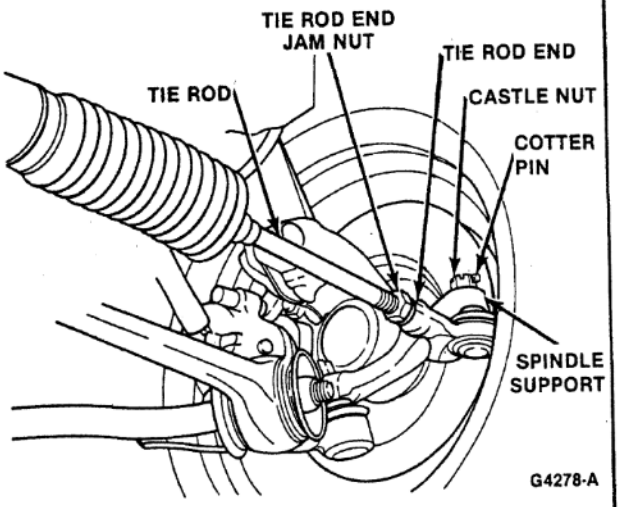
REMOVAL AND INSTALLATION

TIE ROD END

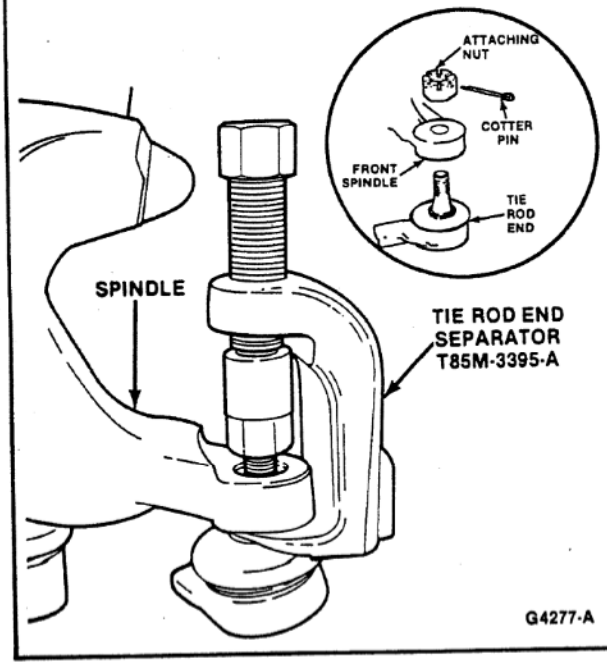
SPECIAL SERVICE TOOL REQUIRED:

Tie Rod End Separator T85M-3395-A

Removal



1. Remove the cotter pin and castle nut attaching the tie rod end to the spindle support.
2. Separate the tie rod end from the spindle support, using Tie Rod End Separator T85M-3395-A, or equivalent.

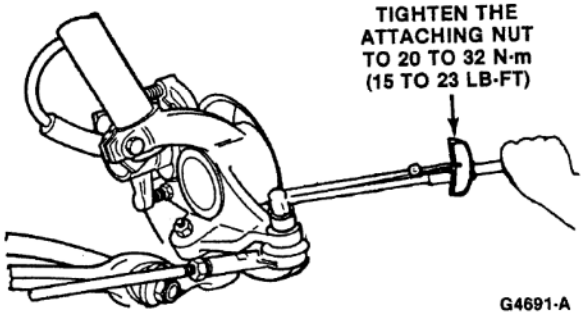


3. Loosen the tie rod end jam nut.
4. Remove the tie rod end.

NOTE: To avoid having to make a large toe-in adjustment, use a piece of tape or a dab of paint to mark the position of the tie rod end.

Installation

1. Install the tie rod end to the marked position.
2. Tighten the tie rod end jam nut.



3. Connect the tie rod to the spindle support and install the castle nut. Tighten the nut to 20 to 32 N·m (15 to 23 lb-ft) and install a new cotter pin.

NOTE: If the slots in the nut do not align with the cotter pin hole, tighten the nut to the next slot. **Never loosen the nut for alignment.**

4. Check and, if necessary, adjust toe-in.

REMOVAL AND INSTALLATION

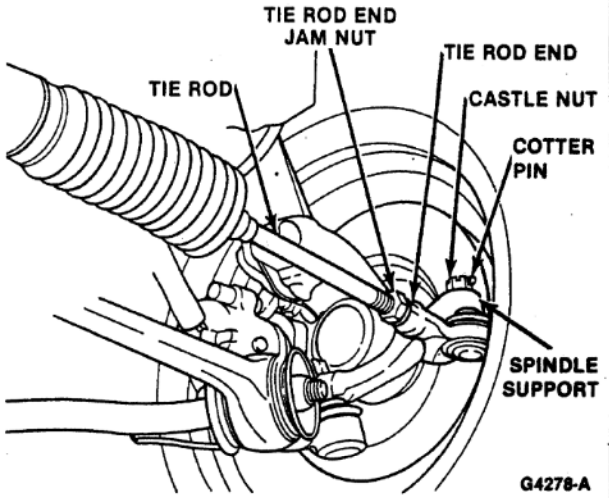
DUST BOOT

SPECIAL SERVICE TOOL REQUIRED:

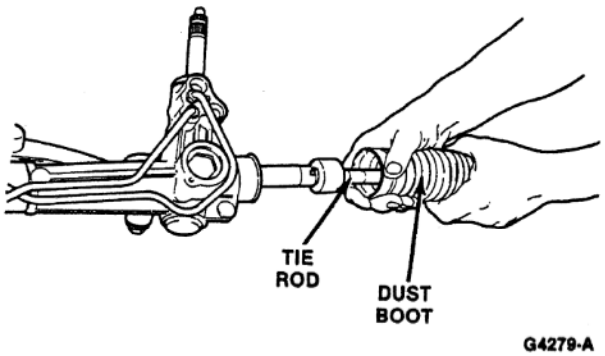
Tie Rod End Separator T85M-3395-A

Removal

1. Remove the tie rod end. If necessary, refer to the procedure in this section.
2. Remove the tie rod end jam nut.

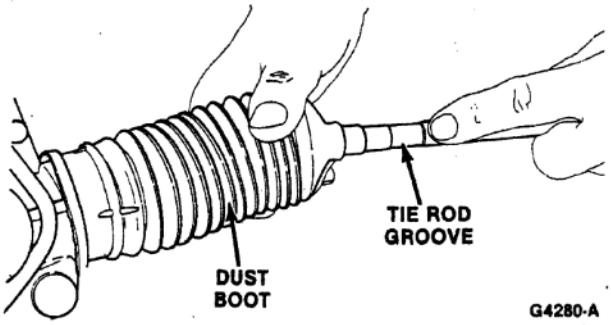


3. Remove the dust boot clamps.
4. Carefully pull the dust boot over the tie rod and remove.

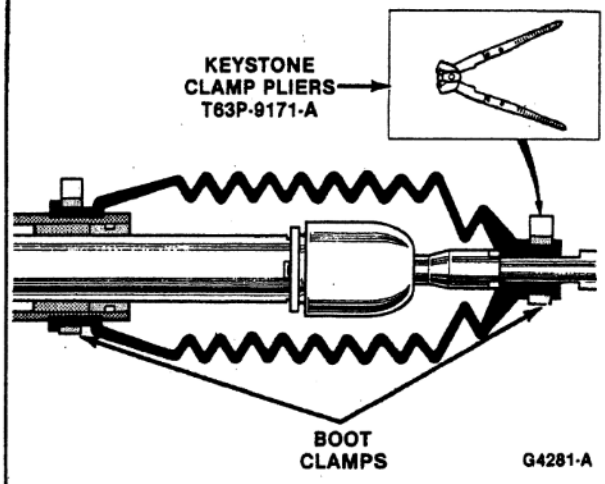


Installation

1. Position the large boot clamp on the steering gear.
2. Install the dust boot. The boot will slide into position much more easily if the tie rod is sprayed with silicone lubricant.
3. Make sure the small end of the dust boot is properly seated in the tie rod groove and that the large end of the boot is properly seated around the ends of the housing. At the right-hand end of the gear, the boot must cover the rack bushing lockwire slot.



4. Install the small boot clamp.
5. Position and tighten the boot clamps using Keystone Clamp Pliers T63P-9171-A.



6. Install the tie rod jam nut and install the tie rod end. If necessary, refer to the procedure in this section.
7. Check and, if necessary, adjust toe-in.

REMOVAL AND INSTALLATION

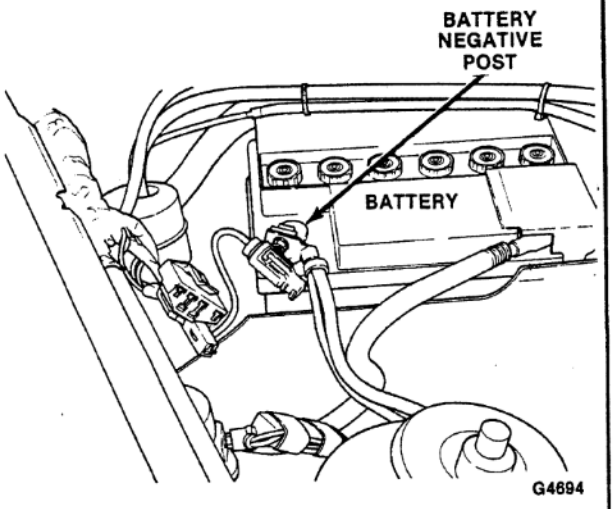
STEERING GEAR

Removal

SPECIAL SERVICE TOOL REQUIRED:

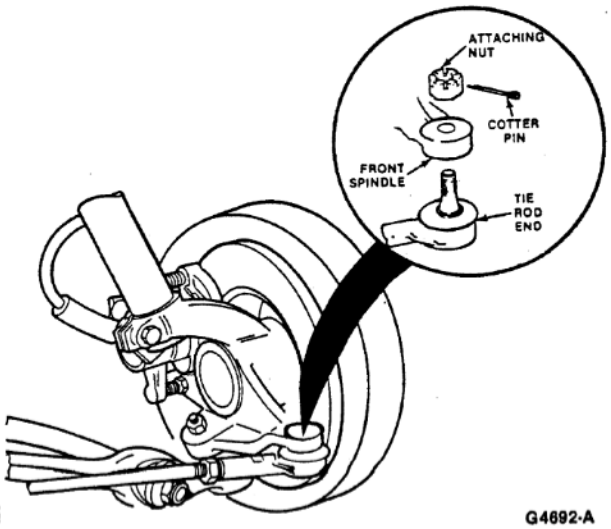
Tie Rod End Separator T85M-3395-A

1. Disconnect the battery negative cable.

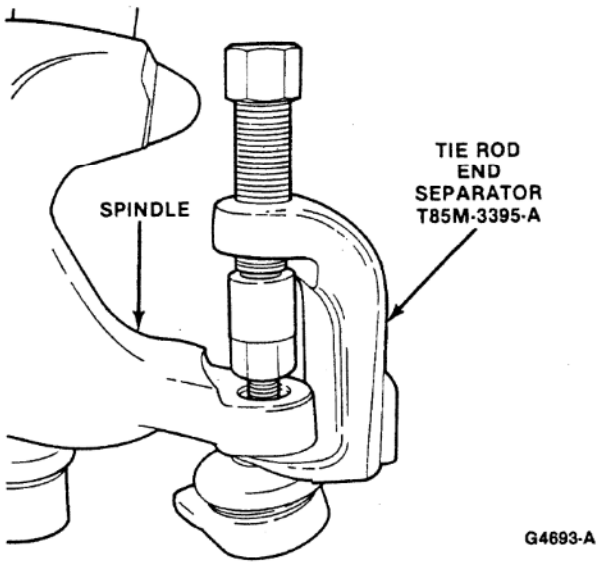


2. Turn the ignition key to position II (ON).

3. Remove the cotter pins and the nuts attaching the tie rod ends to the spindle carriers.

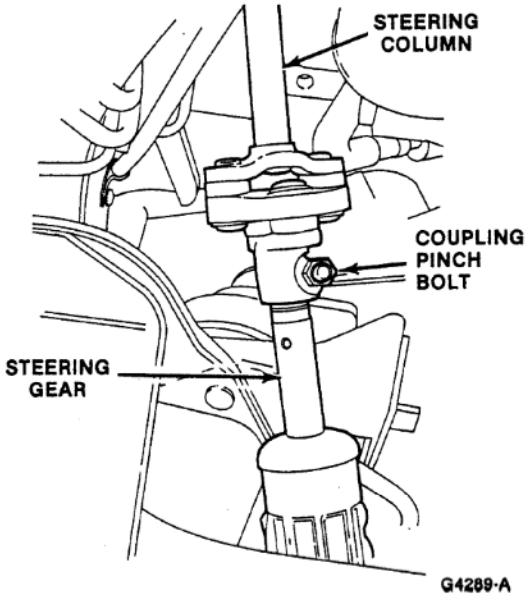


4. Separate the tie rod ends from the spindle carriers using Tie Rod End Separator T85M-3395-A, or equivalent.



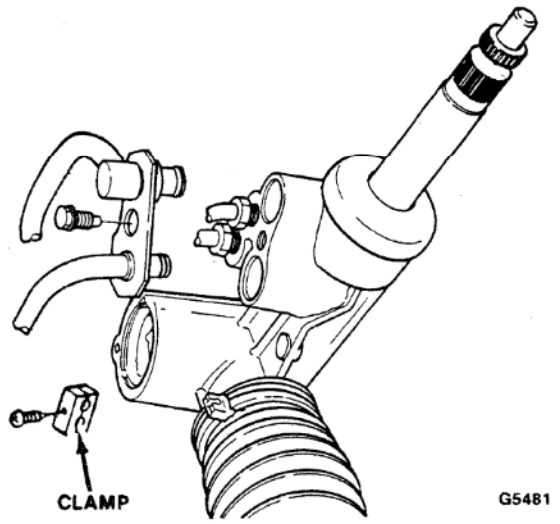
5. Remove the pinch bolt from the flexible coupling.

   Rotate the coupling as necessary to gain access to the pinch bolt.

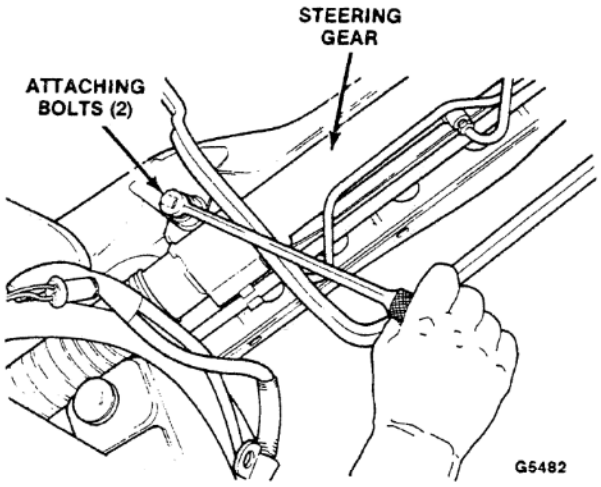


REMOVAL AND INSTALLATION (Continued)

6. Position a drain pan and disconnect the power steering hoses from the steering gear by removing the routing clamp and the washer-head screw securing the pump line plate assembly to the gear housing and pulling the assembly free. Plug the housing ports to prevent entry of contaminants.

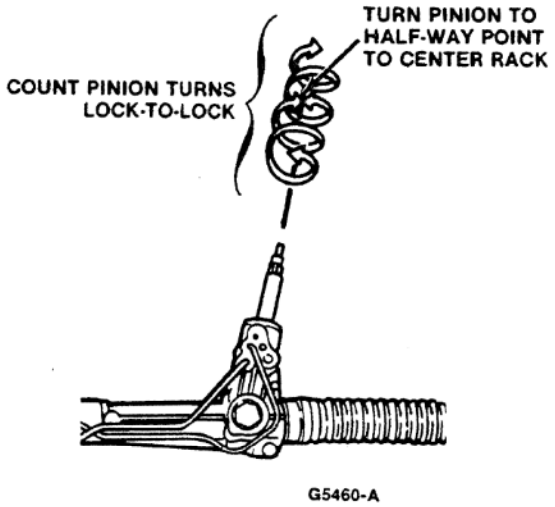


7. Remove the steering gear mounting bolts and the steering gear.
8. Remove rack mounting bushings if required. Refer to procedure in this Section.



Installation

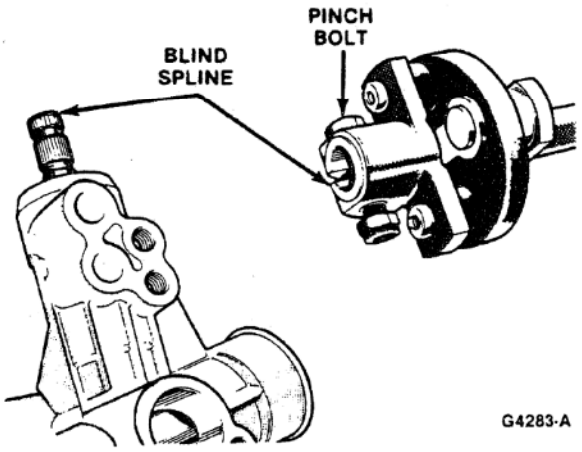
1. Center the steering wheel and turn the ignition key to position O (OFF).
2. Center the steering gear as follows:
   a. Turn the steering gear input shaft clockwise to the full-left-turn stop.
   b. Turn the input shaft counterclockwise and count the number of turns required to move the rack from the full-left-turn stop to the full-right-turn stop.
   c. From the right-turn stop, turn the input shaft clockwise exactly one-half the number of turns counted in Step 2b.



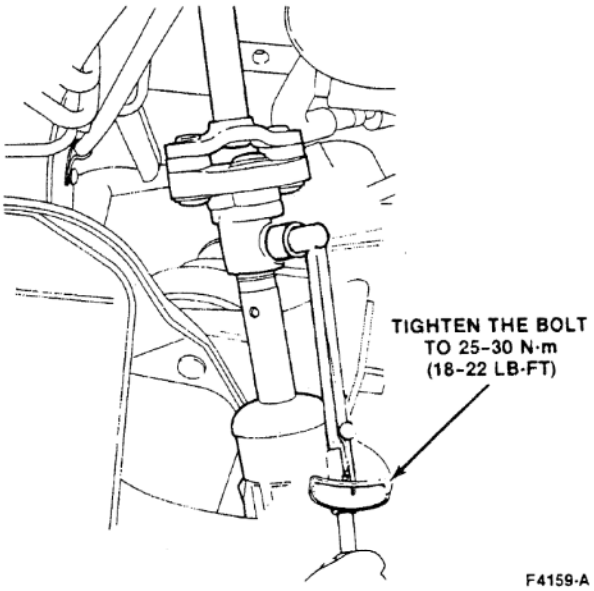
3. Position the steering gear on the crossmember, engaging the flexible coupling with the input shaft. Rock the coupling as necessary to align the blind splines on shaft and coupling.

REMOVAL AND INSTALLATION (Continued)

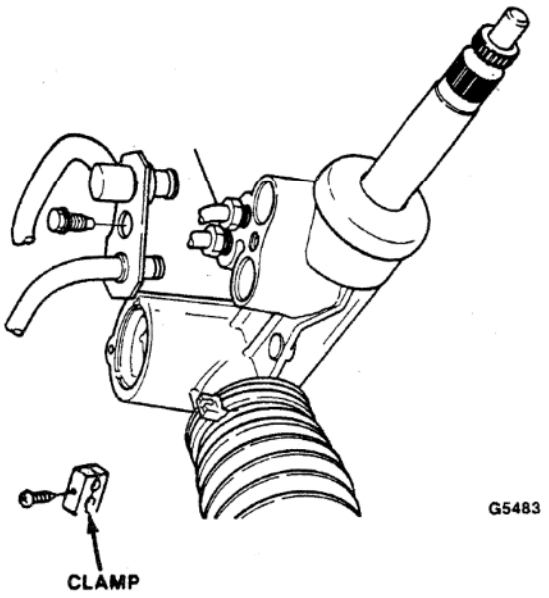
4. Turn the ignition key to position II to unlock the steering column.
5. Turn the steering column, as necessary, to align the blind splines on the coupling and steering gear shaft.
6. Connect the steering gear to the steering column and position on the crossmember.



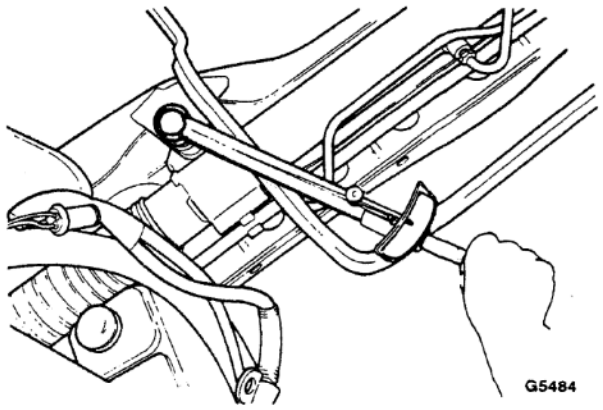
7. Install the steering coupling pin bolt. Tighten the bolt to 25 to 30 N·m (18 to 22 lb-ft).



8. Plug the pump line assembly into the steering gear supply and return ports and secure the line plate with the washer-head screw and routing clamp.



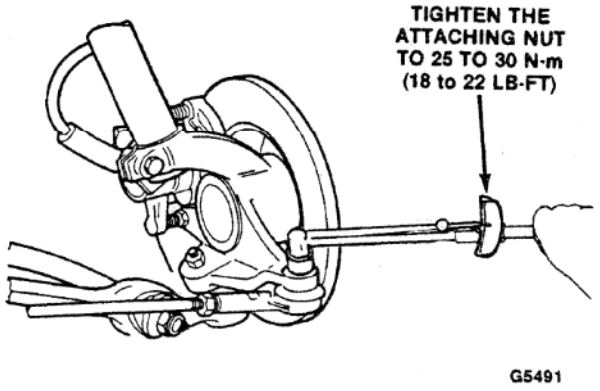
9. Install new steering gear mounting bolts and tighten until snug (about 15 N·m or 11 lb-ft). Then turn the bolts an additional 90°.



REMOVAL AND INSTALLATION (Continued)

10. Connect the tie rods to the spindle carriers and install the castle nuts. Tighten the nuts to 20 to 32 N·m (15 to 23 lb-ft) and install new cotter pins.

NOTE: If the slots in the nut do not align with the cotter pin hole, tighten the nut to the next slot. **Never loosen the nut for alignment.**



11. Turn the ignition key to position O (OFF).
12. Connect the battery negative cable.
13. Fill the power steering pump to the correct level. If necessary, refer to Section 13-51 for the necessary procedure.

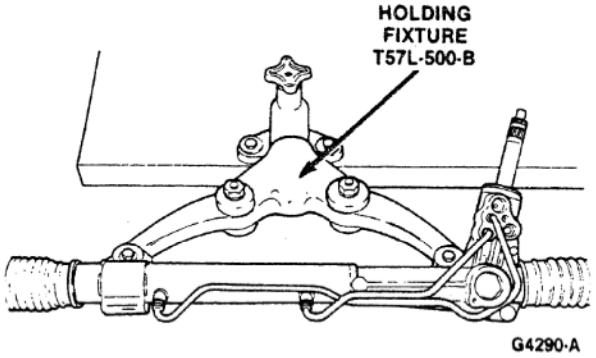
Tie Rod Ball Joints

Removal

SPECIAL SERVICE TOOL REQUIRED:

Holding Fixture T57L-500-B

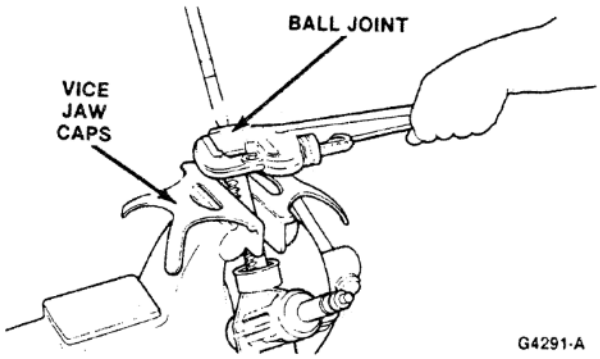
1. Remove the steering gear from the vehicle. If necessary, refer to the procedure in this Section.
2. Mount the steering gear in Holding Fixture T57L-500-B, or equivalent.



3. Remove the tie rod end and dust boots. If necessary, refer to the procedures in this Section.
4. Rotate the input shaft until the rack teeth extend from the side of the housing.
5. Grip the rack teeth in a vise equipped with protective jaw caps.

CAUTION: The rack must be held against turning to prevent damage to the pinion. If not held in this manner, the twisting force applied to the rack during ball joint removal could damage the pinion.

6. Remove the ball joint/tie rod assemblies using a suitable wrench.



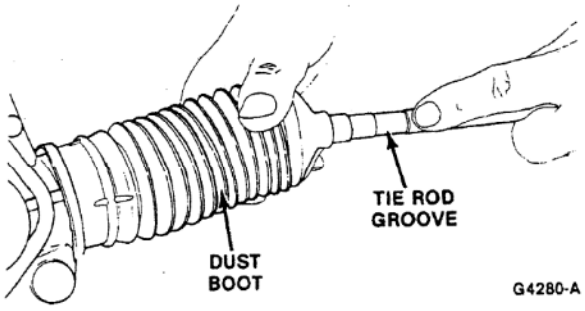
NOTE: The ball joint and tie rod cannot be disassembled. They are serviced only as an assembly.

Installation

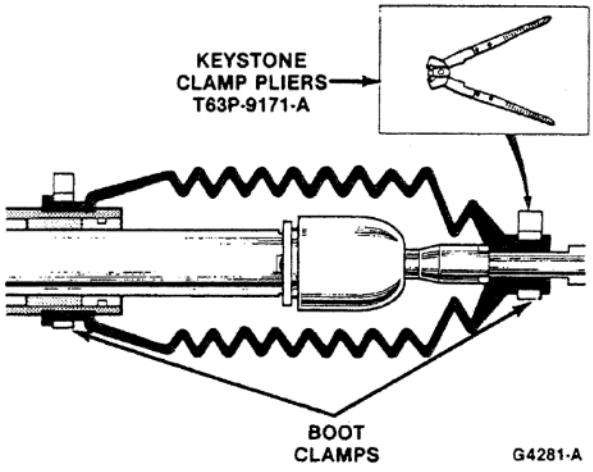
1. Install the ball joint/tie rod assemblies.
2. Be sure the rack is secured against rotation. Coat the threads of the rod with Loctite 270 and tighten the ball joint housing to 72 to 88 N·m (53 to 65 lb-ft).
3. Position the large boot clamp on the steering gear.
4. Install the dust boot. The boot will slide into position much more easily if the tie rod is sprayed with silicone lubricant.

REMOVAL AND INSTALLATION (Continued)

5. Make sure the small end of the dust boot is properly seated in the tie rod groove and that the large end of the boot is properly seated around the ends of the housing. At the right-hand end of the gear, the boot must cover the rack bushing lockwire slot.



6. Install the small boot clamp.
7. Position and tighten the boot clamps using Keystone Clamp Pliers T63P-9171-A.



8. Install the tie rod jam nut and install the tie rod end. If necessary, refer to the procedure in this Section.
9. Install the steering gear. If necessary, refer to the procedure in this Section.

   Check and, if necessary, adjust toe-in.

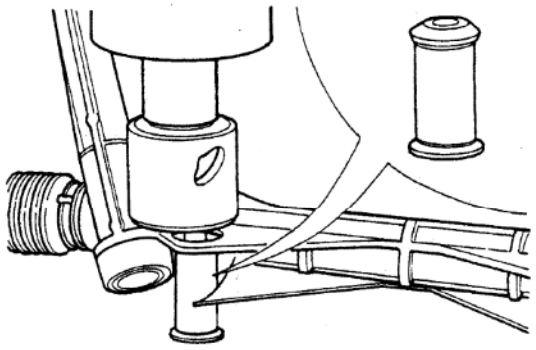
Rack Mounting Bushing

Removal

CAUTION: Rack mounting bushings may be damaged during removal and cannot be reused.

NOTE: Bushings can be pressed out in either direction.

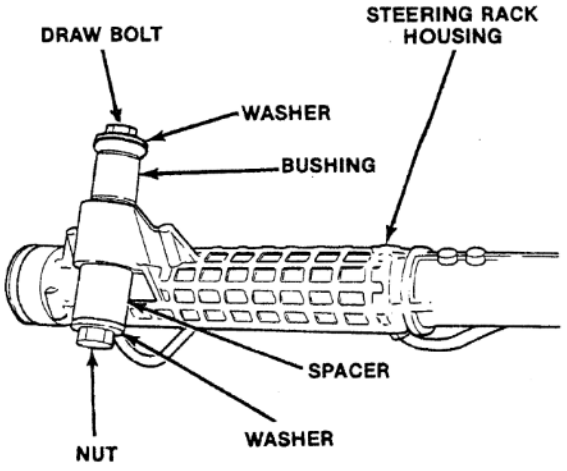
1. Remove steering gear assembly. Refer to procedure in this Section.
2. Carefully position steering gear in a press. Using a suitable tool, press out old bushing.
3. Repeat for other bushing.



Installation

1. Make sure bushing bores in rack housing are clean and free of nicks or burrs.
2. Lightly lubricate the new bushings.
3. Position new bushing with draw bolt (or threaded rod), two washers, suitable spacer (or socket) and a nut as shown.

   NOTE: Draw bolt used to install bushings must have enough threads to allow the bushing to be drawn all the way into the rack housing. When possible, use threaded rod.



4. Tighten nut to draw new bushing into rack housing.
5. Remove nut, washers, spacer, and draw bolt.
6. Repeat procedure for other bushing.
7. Install steering gear assembly. Refer to procedure in this Section.

DISASSEMBLY AND ASSEMBLY

POWER STEERING GEAR

Disassembly

SPECIAL SERVICE TOOL REQUIRED:

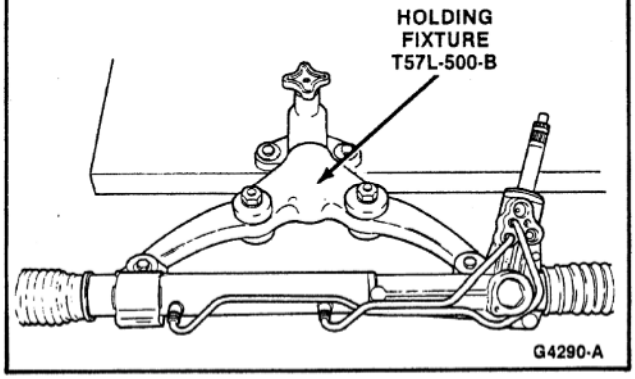
Holding Fixture	T57L-500-B
Yoke Plug Hex Adapter	T85M-3504-C
Rack Bushing Lock Ring Wrench	T77P-3504-A
Puller Attachment	T58L-100-B
Slide Hammer	T59L-101-A
Teflon Ring Replacer	T74P-3504-G
Teflon Ring Sizing Tool	T74P-3504-H
Mandrel	T81P-3504-M1
Ring Pusher	T81P-3504-M2
Sizing Tube	T81P-3504-M3
Spacers (2)	T81P-3504-M4

NOTE: The M1 through M4 tools are part of Seal Installation Kit T81P-3504-M.

Rack Oil Seal Replacer	T78P-3504-K
Pinion Bearing Replacer	T81P-3504-H
Protective Sleeve	D83P-3504-A
Rack Seal Protector Sleeve	T74P-3504-J
Pinion Shaft Torque Adapter	T85M-3504-B
Keystone Clamp Pliers	T63P-9171-A
Lower Pinion Seal Replacer	T81P-3504-F

Disassembly

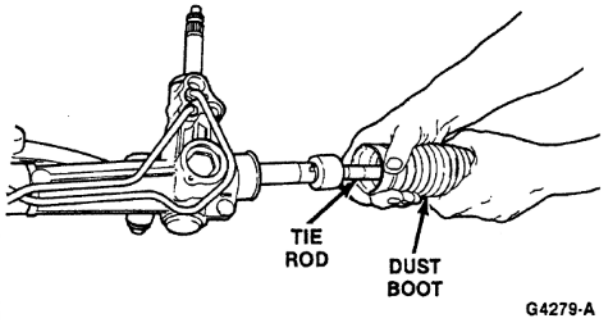
1. Mount the steering gear in Holding Fixture T57L-500-B, or equivalent.



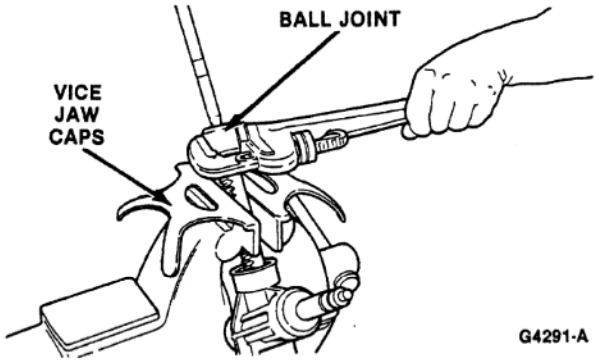
2. Remove the tie rod ends and locknuts. If necessary, refer to the procedure in this section.

3. Cut and remove the dust boot clamps. Discard the clamps.

4. Carefully pull the dust boots over the tie rods and remove.



5. Remove the tie rod ball joints. If necessary, refer to the procedure in this section.

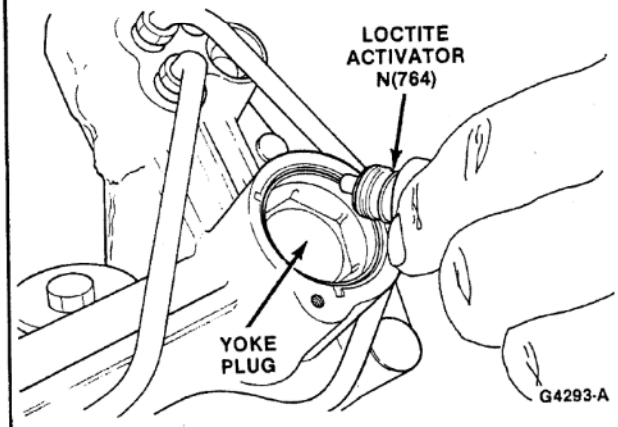


DISASSEMBLY AND ASSEMBLY

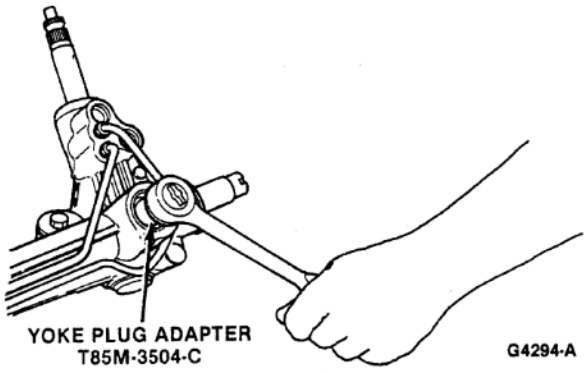
POWER STEERING GEAR

Disassembly (Continued)

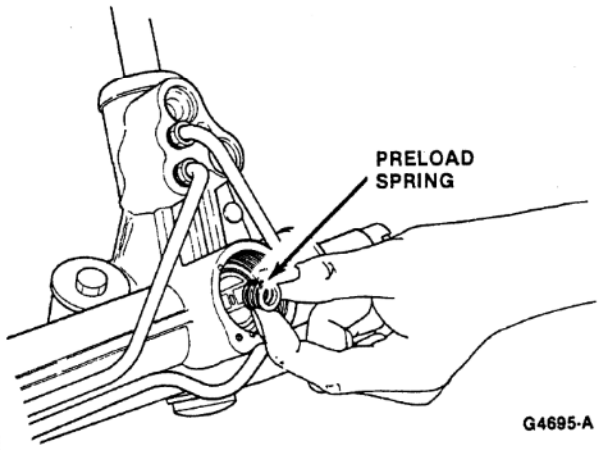
6. Apply Loctite Activator N(764), or equivalent, on the yoke plug threads to loosen the Loctite sealant applied during assembly of the gear.

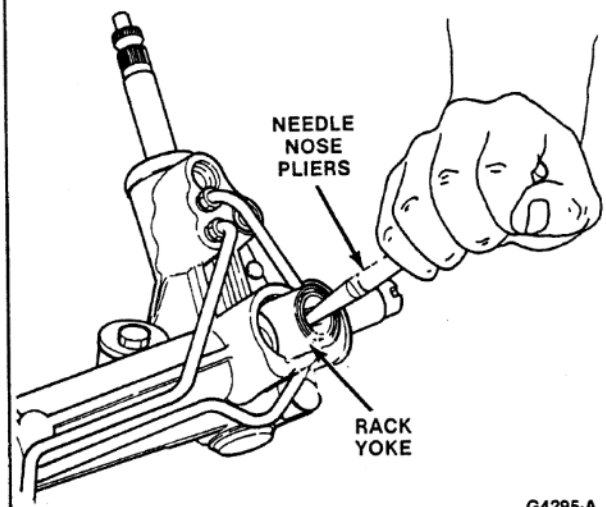


7. Remove the yoke plug using Yoke Plug Hex Adapter T85M-3504-C, or equivalent.



8. Remove the preload spring and rack yoke.



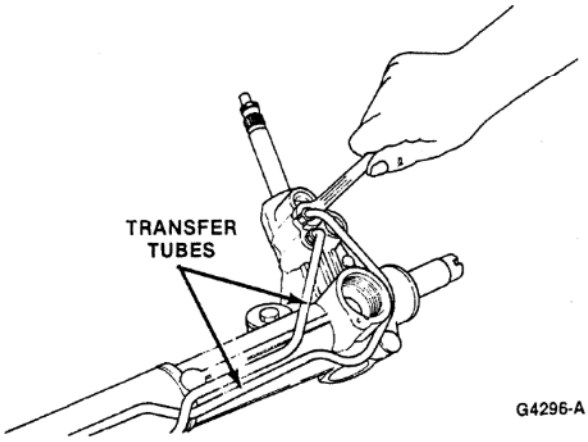


DISASSEMBLY AND ASSEMBLY

POWER STEERING GEAR

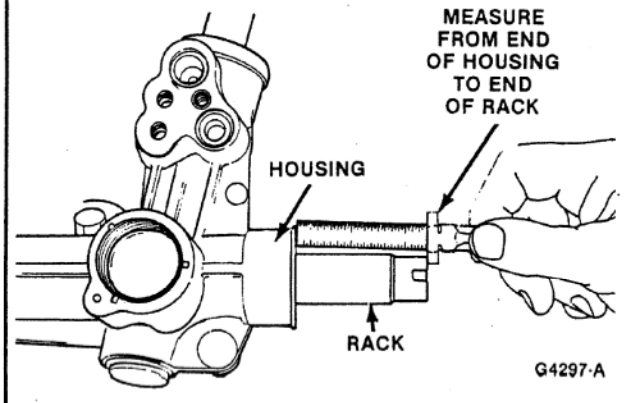
Disassembly (Continued)

9. Remove the transfer tubes and drain fluid from rack and valve body ports.

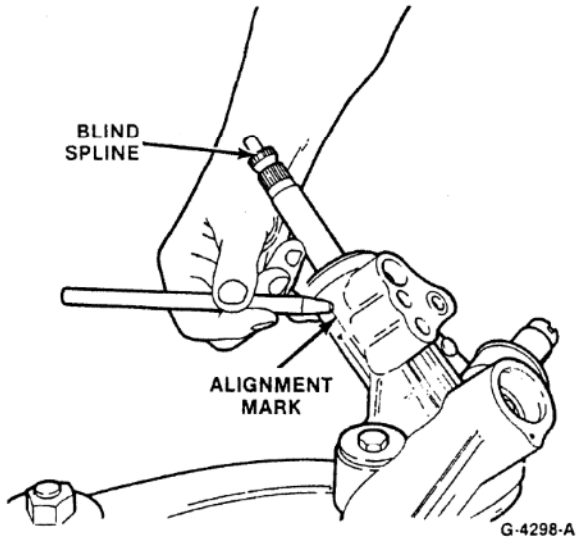


10. Center the steering gear. If necessary, refer to the procedure in this section.

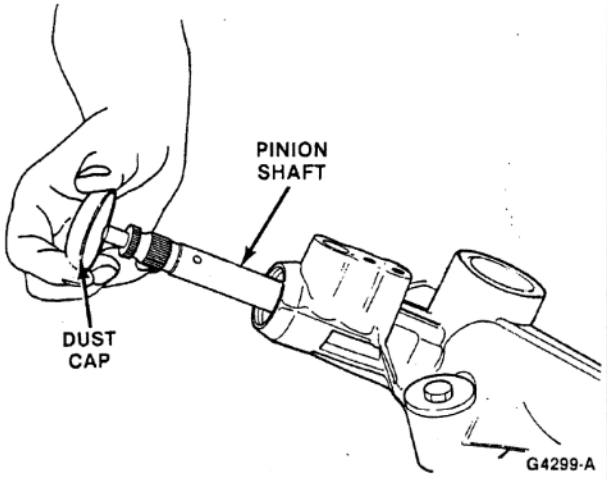
11. Measure and record the distance the rack extends from the pinion end of the housing. Make the measurement from the edge of the housing to the end of the rack.



12. Mark the housing in line with the blind spline on the input shaft.



13. Remove the pinion shaft dust cap.

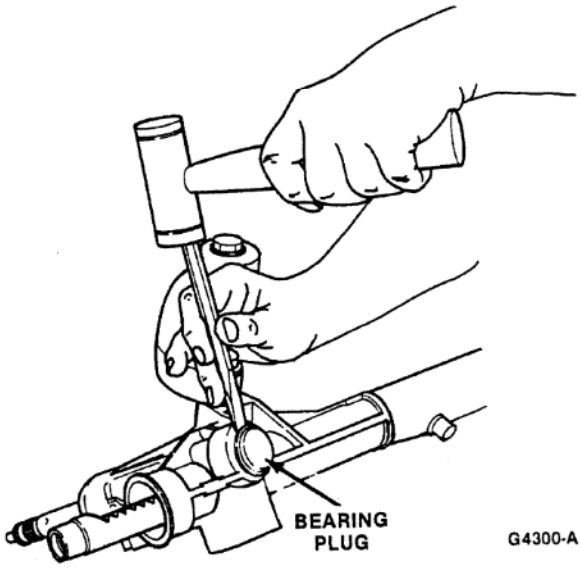


DISASSEMBLY AND ASSEMBLY

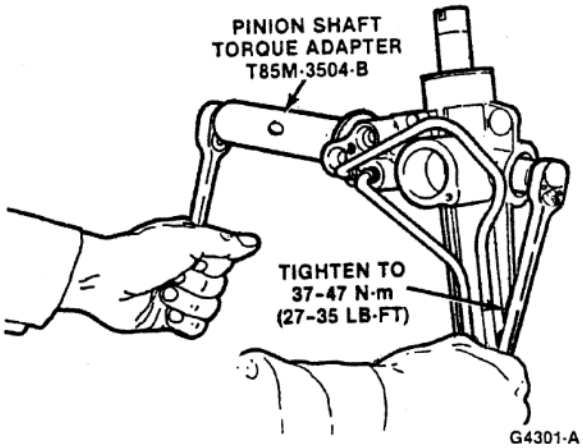
POWER STEERING GEAR

Disassembly (Continued)

14. Remove the pinion lower bearing bore plug. Unseat the plug with a chisel or screwdriver and pry out.

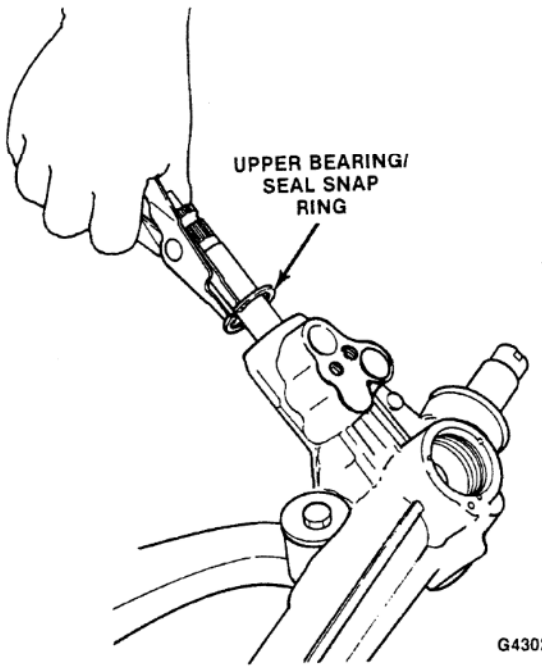


15. While holding the Pinion Shaft Torque Adapter T85M-3504-B, remove the pinion bearing locknut.

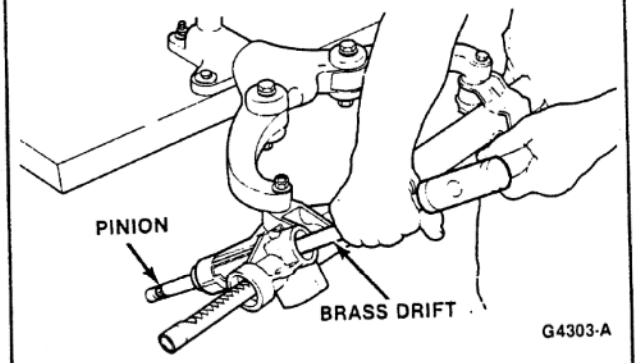


CAUTION: Do not allow the input shaft to rotate during removal of the locknut. Damage to the rack can occur if it is allowed to jam against either turn stop.

16. Remove the pinion upper bearing and seal retaining snap ring.



17. Use a brass drift to drive the end of the pinion shaft out of the lower bearing.

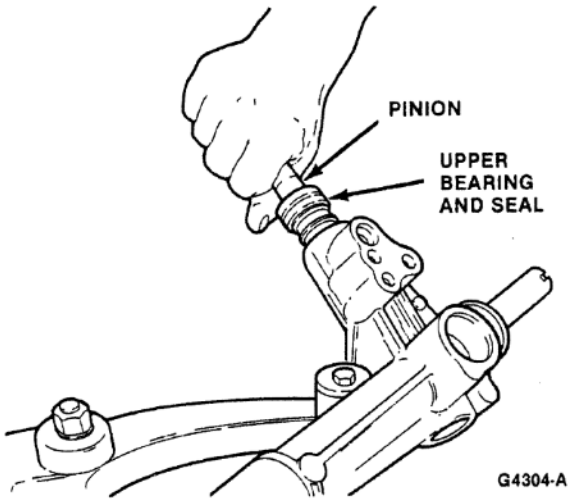


DISASSEMBLY AND ASSEMBLY

POWER STEERING GEAR

Disassembly (Continued)

18. Pull the input shaft/pinion assembly out of the housing upper end.

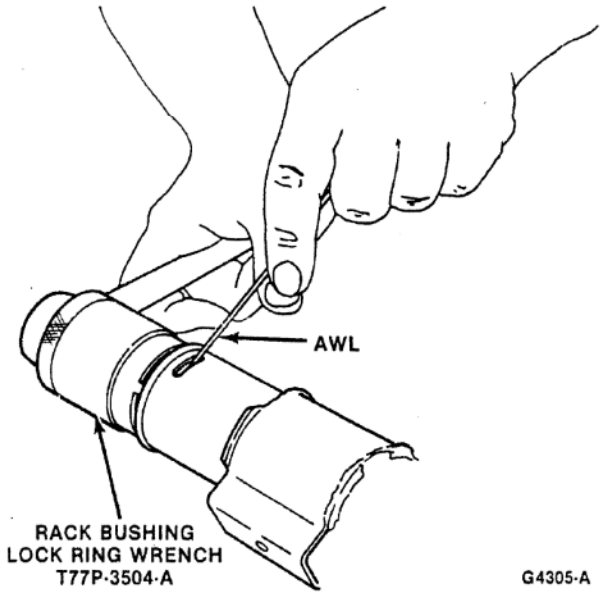


NOTE: The upper bearing and seal will be removed with the pinion.

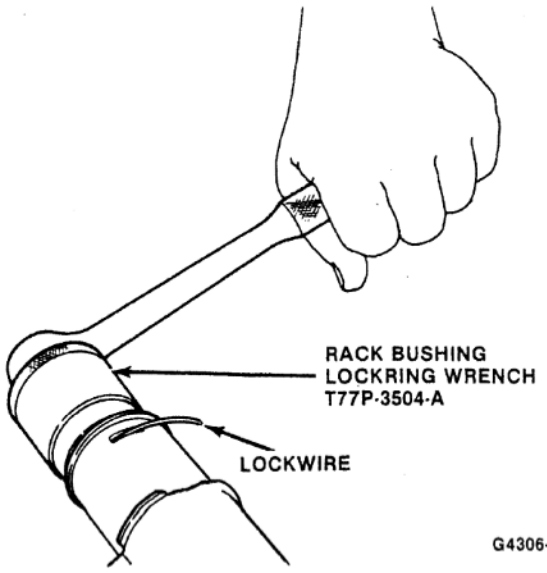
19. Push the rack toward the pinion end of the housing until it bottoms in the housing.

20. Using Rack Bushing Lock Ring Wrench T77P-3504-A, or equivalent, turn the rack bushing clockwise until the free end of the lockwire is visible through the slot in the housing.

21. Use an awl or other pointed tool to raise the end of the lockwire. While holding the lockwire, turn the rack bushing counterclockwise to start the wire through the slot.



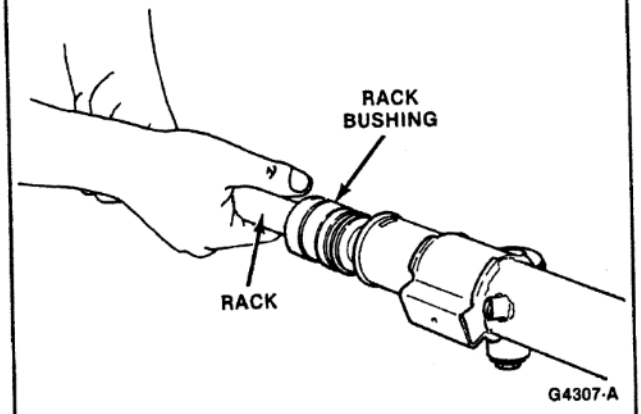
22. Continue turning the bushing to remove the lockwire through the housing slot.



DISASSEMBLY AND ASSEMBLY

POWER STEERING GEAR
Disassembly (Continued)

23. Pull the rack out of the housing. The rack piston will pull the bushing out of the housing.



NOTE: If the rack bushing is stuck in the housing, proceed as follows:

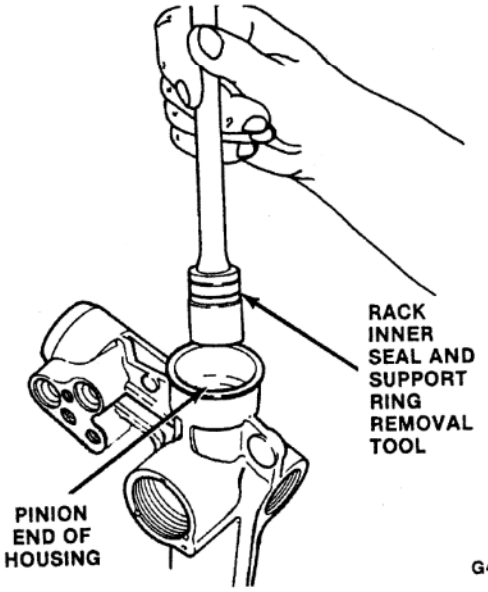
a. Install a tie rod and ball joint assembly.

b. Install the weight from Slide Hammer T50T-100-A onto the tie rod.

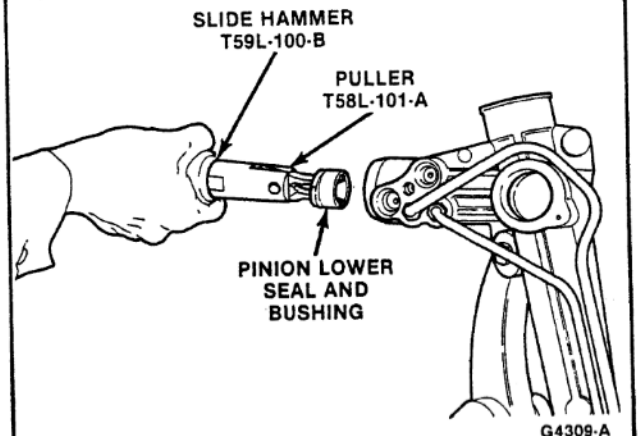
c. Install a flat washer and the tie rod end locknut.

d. Using the slide hammer weight against the washer and locknut, pull the rack bushing out of the housing.

24. To remove the rack inner seal and support ring, improvise a drift approximately 26 mm (1.03 in.) in diameter. A socket wrench and long extension will work. Drive the ring and seal out of the rack bushing end of the cylinder.



25. Remove the pinion lower seal and bushing, using Puller T58L-101-A and Slide Hammer T59L-100-B, or equivalent.

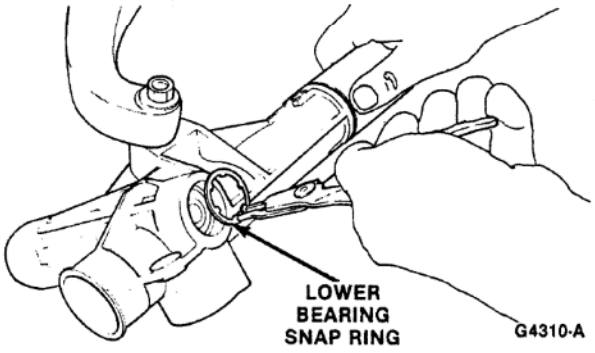


DISASSEMBLY AND ASSEMBLY

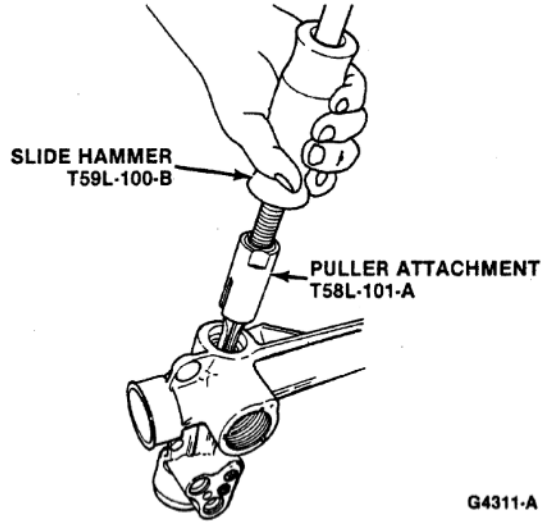
POWER STEERING GEAR

Disassembly (Continued)

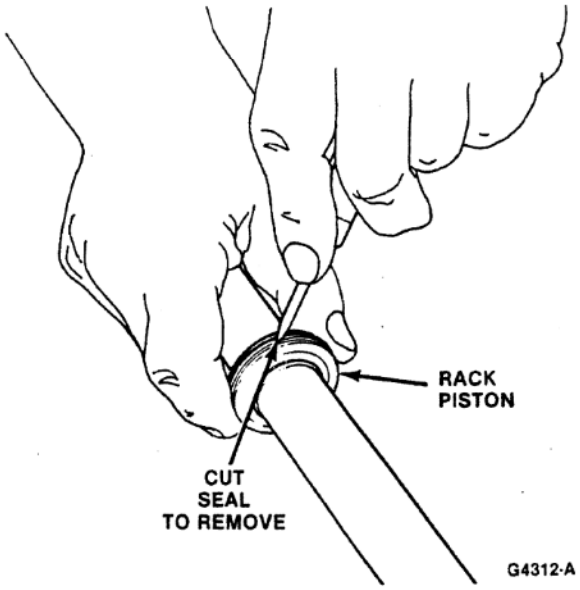
26. Remove the pinion lower bearing retaining snap ring.



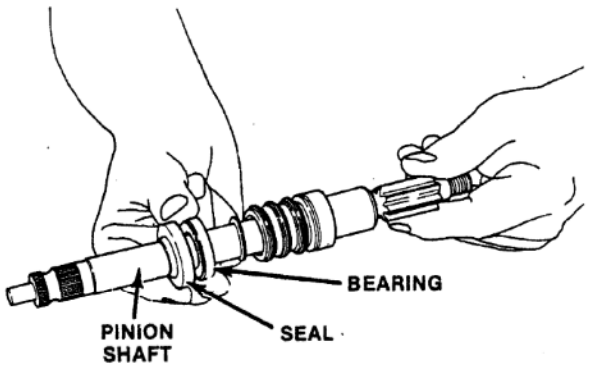
27. Remove the pinion lower bearing, using Puller Attachment T58L-101-A and Slide Hammer T59L-100-B, or equivalent.



28. Remove the seal ring from the rack piston by pushing to one side and cutting with a small sharp knife. Be careful to avoid nicking piston lands.



29. Remove the seal and bearing from the pinion shaft.

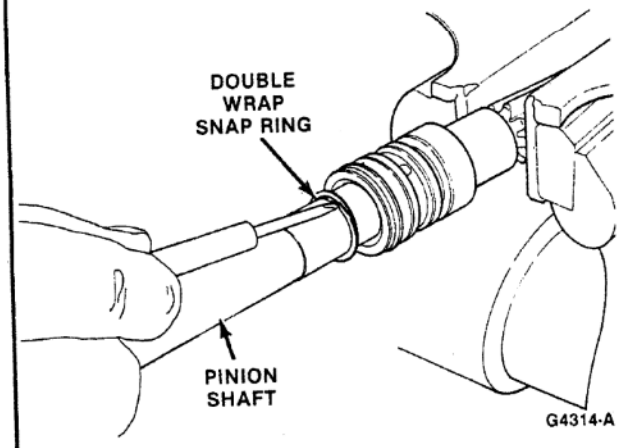


DISASSEMBLY AND ASSEMBLY

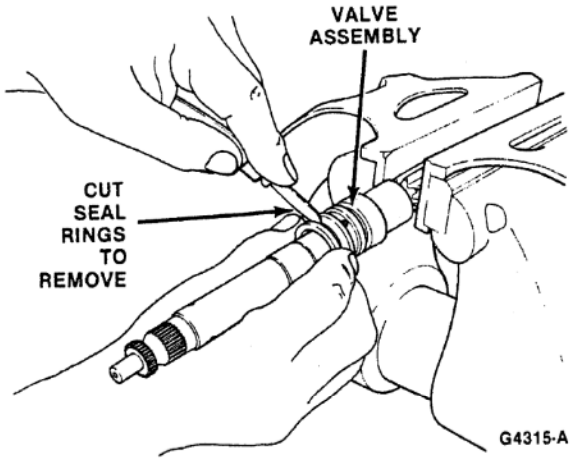
POWER STEERING GEAR

Disassembly (Continued)

30. With a sharp instrument, pry the end of the double-wrap snap ring out of its groove in the input shaft. Unwind the ring and remove it from the shaft.

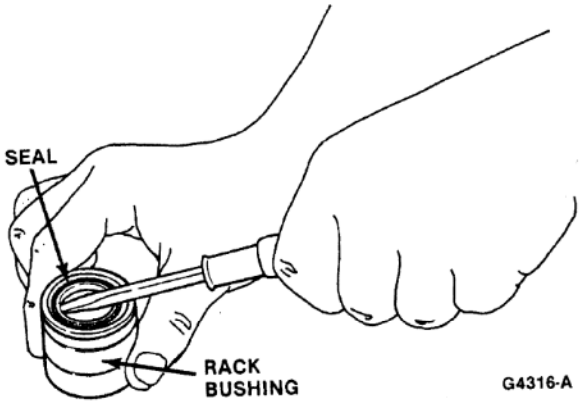


31. Remove the seal rings from the valve assembly by pushing them to one side and cutting with a small sharp knife. Use care to prevent nicks or scratches on the lands between the seal rings.



CAUTION: Do not disassemble the valve. The only serviceable parts are the seal rings.

32. Pry the oil seal out of the rack bushing and discard the seal.



DISASSEMBLY AND ASSEMBLY

COMPONENT INSPECTION CHART
STEERING GEAR

COMPONENT	CHECK FOR
RACK AND PINION GEARS	• Chipped, broken or otherwise damaged gear teeth • Scoring or pitting in the seal areas • Damaged tie rod ball joint threads or seat • Damaged rack piston • Scored or otherwise damaged bearing or bushing surfaces • Damaged splines or threads
GEAR HOUSING	• Cracks • Damaged tube seats • Scored or pitted valve seal area • Damaged bearing or bushing seats • Damaged threads in yoke bore or on yoke plug
TIE RODS AND BALL JOINTS	• Loose or worn ball seat • Bent condition • Damaged tie rod end or ball joint threads
DUST BOOTS	• Cuts or tears • Loss of flexibility • Deterioration **NOTE:** The boots are made of naturally stiff material but should telescope freely.
RACK BUSHING	• Worn or scored rack bearing surface • Damaged seal seat • Damaged lock wire groove
PINION BEARINGS	• Roughness • Damaged roller or bearing surfaces
TRANSFER TUBES	• Bent or broken tubes • Damaged tube seats • Damaged fittings or threads

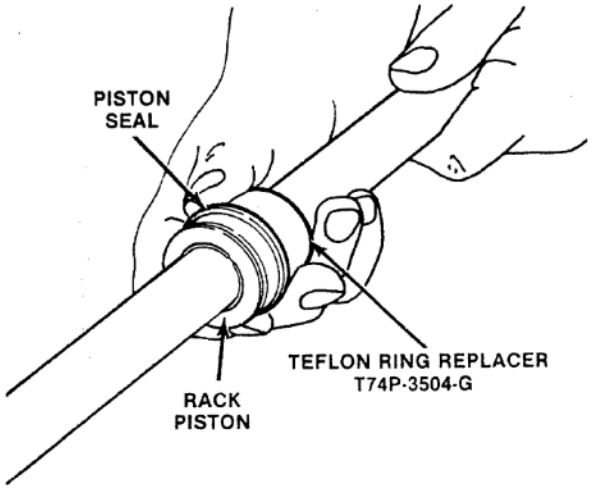
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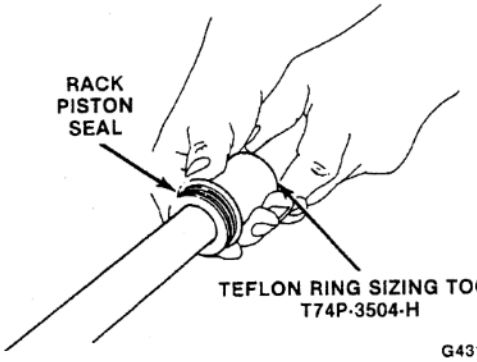
DISASSEMBLY AND ASSEMBLY

POWER STEERING GEAR

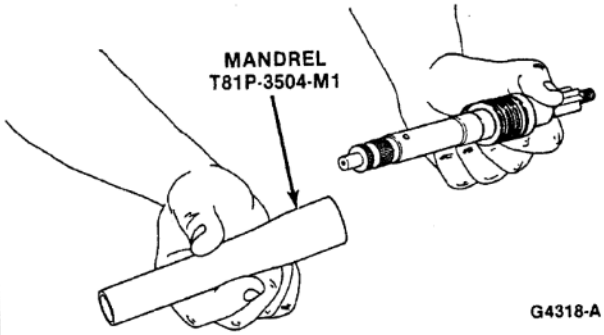
Assembly

1. Lubricate the rack piston seal with automatic transmission fluid or power steering fluid. Install on the piston using Teflon Ring Replacer T74P-3504-G and Teflon Ring Sizing Tool T74P-3504-H, or equivalent.



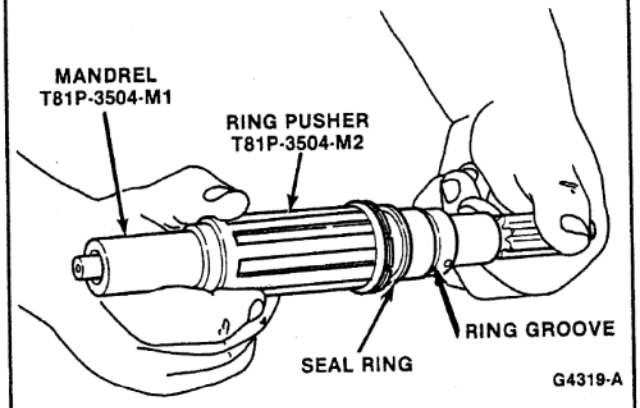


2. Install the seals on the valve assembly as follows:
   a. Install Mandrel T81P-3504-M1, or equivalent, over the valve assembly and lubricate with automatic transmission fluid or power steering fluid.



   b. Lubricate and install a seal on the mandrel.

   c. Slide Ring Pusher T81P-3504-M2 or equivalent over the mandrel and push down rapidly to force the seal over the mandrel ramp into the seal groove.



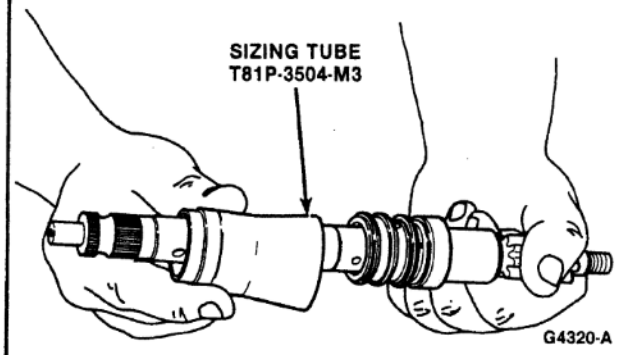
   d. Remove the mandrel.

DISASSEMBLY AND ASSEMBLY

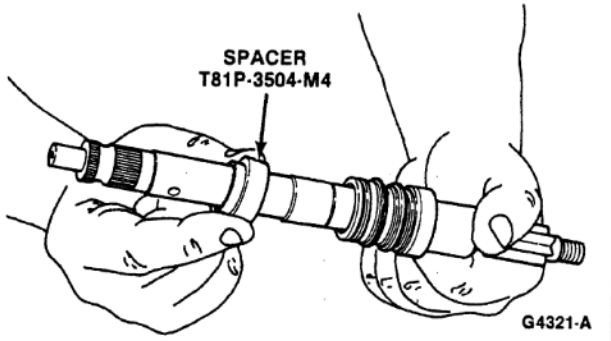
POWER STEERING GEAR

Assembly (Continued)

e. Lubricate the inside of Sizing Tube T81P-3504-M3, or equivalent, and slowly work the tool over the seal using a rotating motion. Use care to prevent deforming or cutting of the seal.

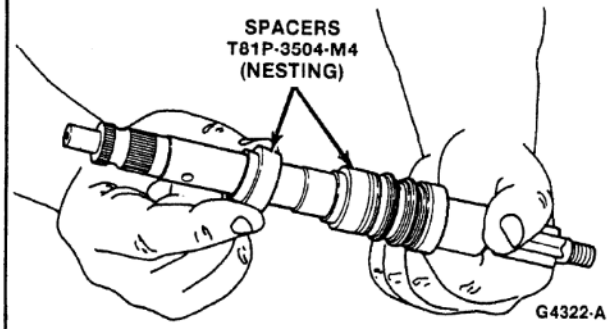


f. Install Spacer T81P-3504-M4, or equivalent. The spacer will align the mandrel with the second seal groove.



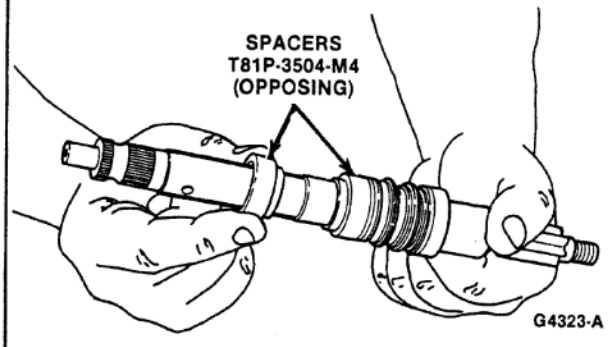
g. Repeat Steps a, b, c, d and e.

h. Install a second Spacer T81P-3504-M4, or equivalent, nesting with the first spacer. These spacers will align the mandrel with the third seal groove.



i. Repeat Steps a, b, c, d and e.

j. Remove the second spacer, turn it over and install on the shaft, opposing the first spacer. The spacers will now align the mandrel with the fourth seal groove.



k. Repeat Steps a, b, c, d and e.

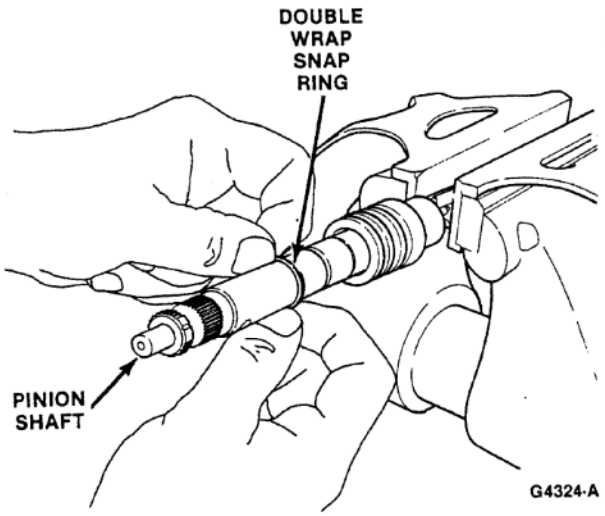
l. Remove the mandrel and spacers.

DISASSEMBLY AND ASSEMBLY

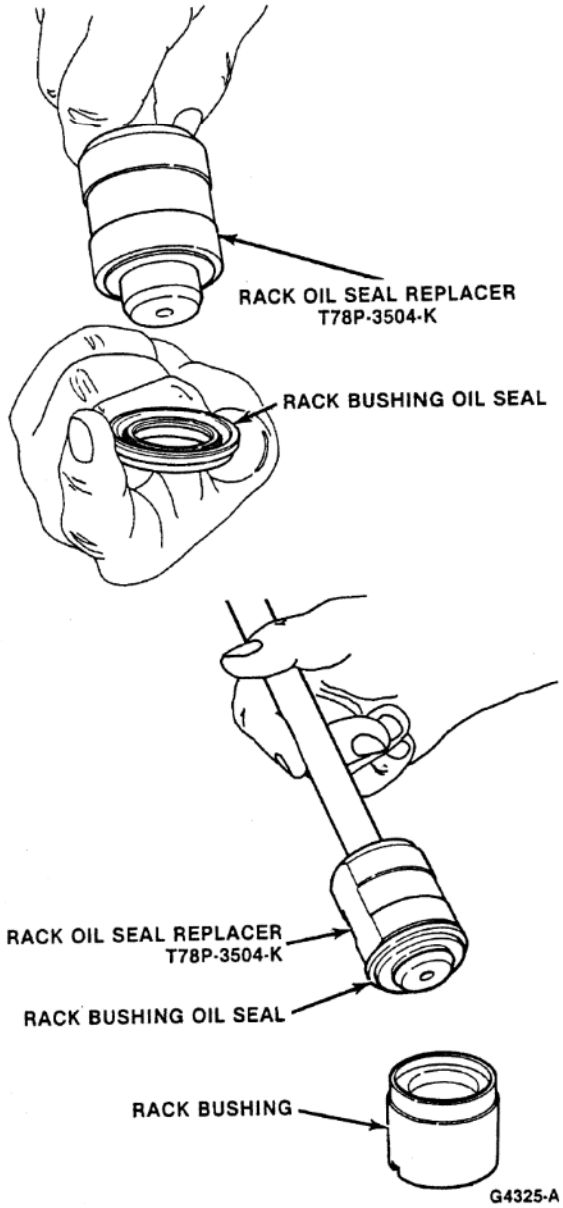
POWER STEERING GEAR

Assembly (Continued)

3. Install the double-wrap snap ring in its groove on the input shaft.



4. Install the rack bushing seal, using Rack Oil Seal Replacer T78P-3504-K, or equivalent, with the seal lip and spring facing the tool.

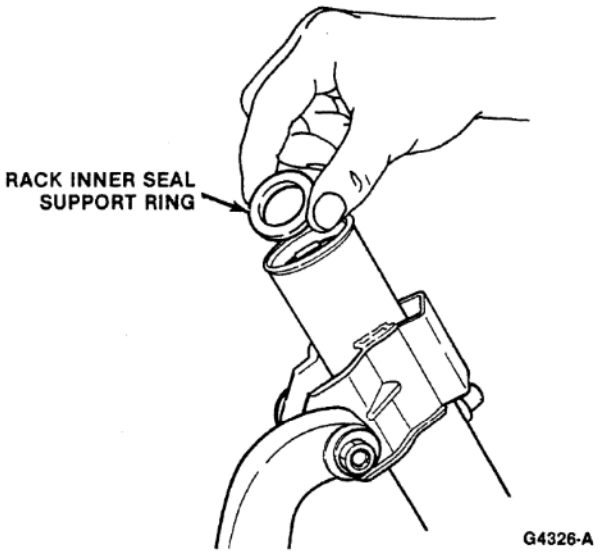


DISASSEMBLY AND ASSEMBLY

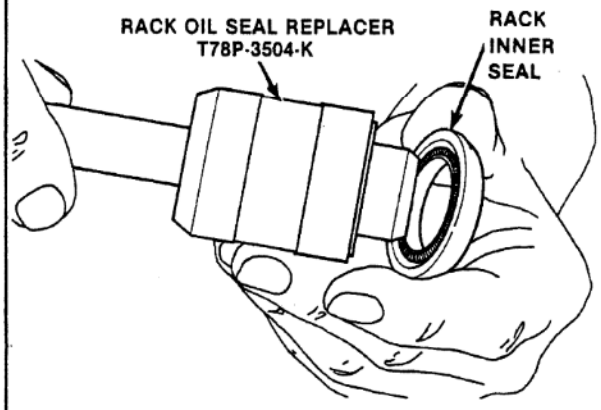
POWER STEERING GEAR

Assembly (Continued)

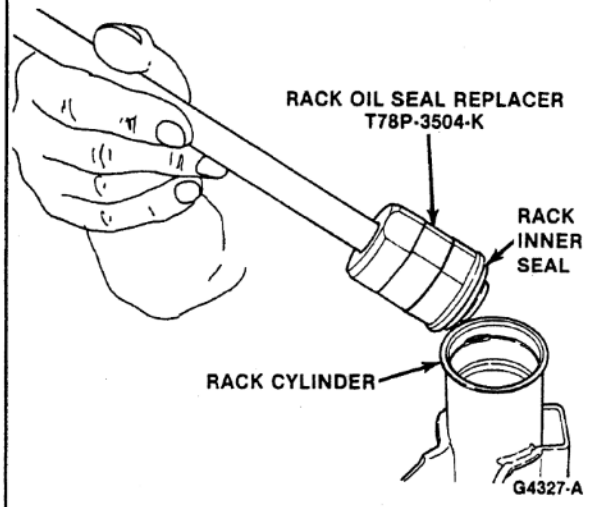
5. Install the rack inner seal support ring in the rack cylinder, using the rack oil seal replacer to seat and center it, if necessary.



6. Install the rack inner seal, using Rack Oil Seal Replacer T78P-3504-K, or equivalent.



NOTE: The seal lip and spring must be positioned against the tool.

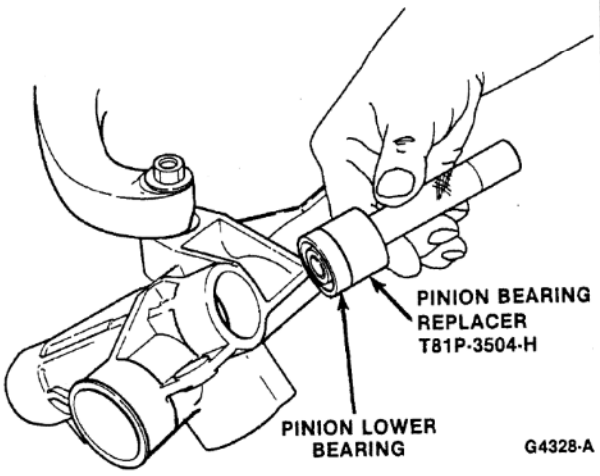


DISASSEMBLY AND ASSEMBLY

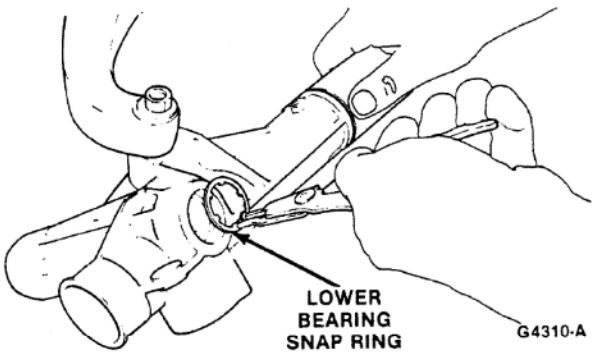
POWER STEERING GEAR

Assembly (Continued)

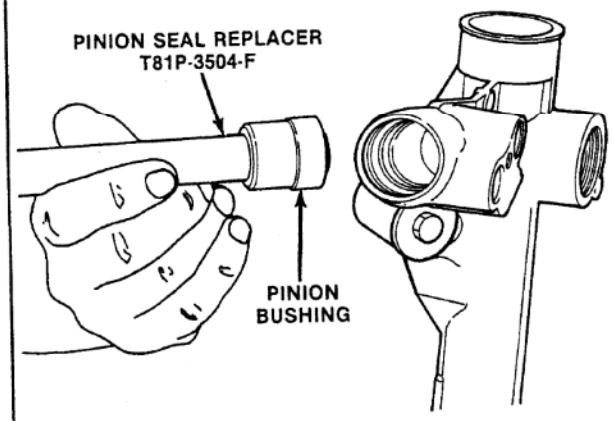
7. Install the pinion lower bearing using Pinion Bearing Replacer T81P-3504-H, or equivalent.

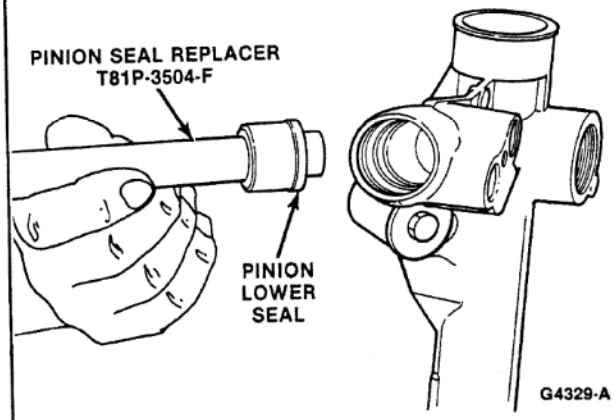


8. Install the pinion lower bearing retaining snap ring.



9. Install the pinion bushing and lower seal using Pinion Seal Replacer T81P-3504-F, or equivalent.





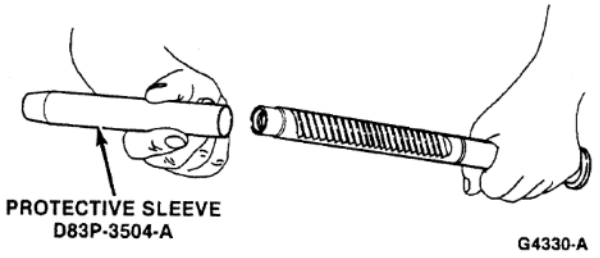
DISASSEMBLY AND ASSEMBLY

POWER STEERING GEAR

Assembly (Continued)

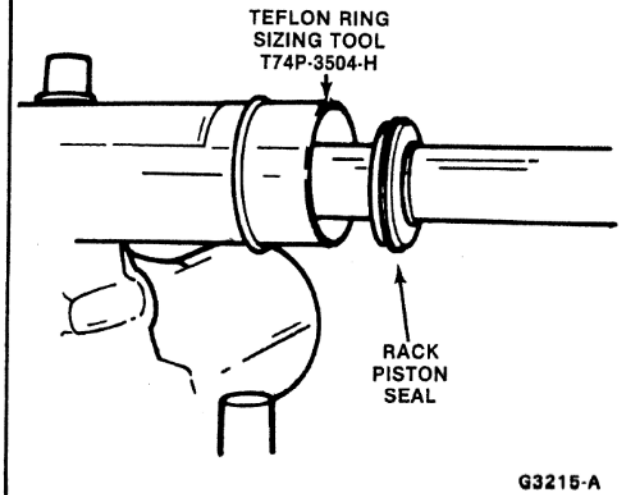
10. Pack the rack teeth and coat the yoke bearing surface with Lubricant C3AZ-19578-A, or equivalent.

11. Install Protective Sleeve D83P-3504-A, or equivalent, over the rack teeth.

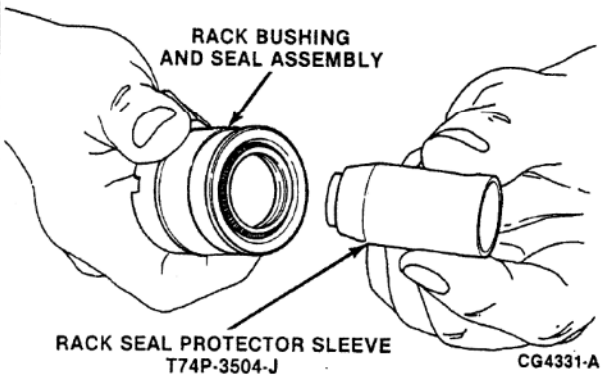


12. Position Teflon Ring Sizing Tool T74P-3504-H, or equivalent, in the mouth of the rack cylinder. Lubricate the tool bore and push the rack through the sizing tool into the housing. Continue pushing the rack until the piston bottoms in the housing.

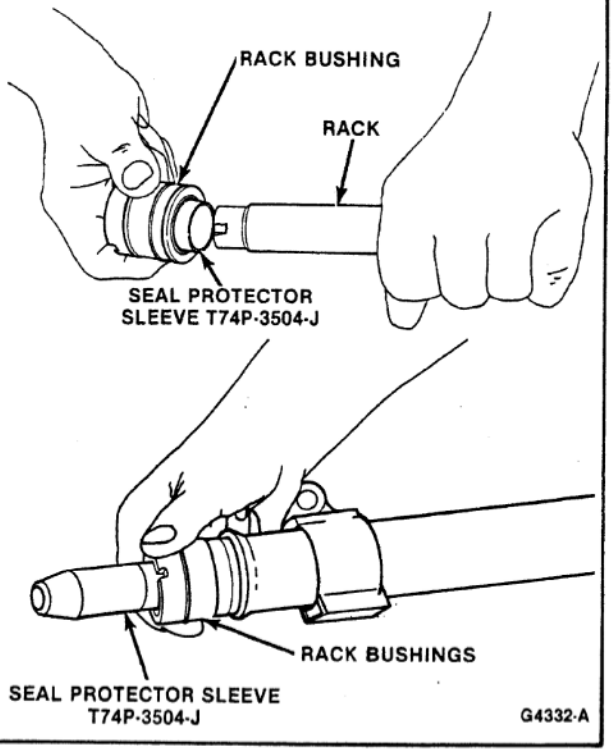
    Remove the protective sleeve and sizing tool.



13. Lubricate Rack Seal Protector Sleeve T74P-3504-J, or equivalent, and position it in the rack bushing and seal assembly.



14. Install the rack bushing with the seal facing in. Light tapping with a plastic tipped hammer may be necessary to seat the bushing in the housing.



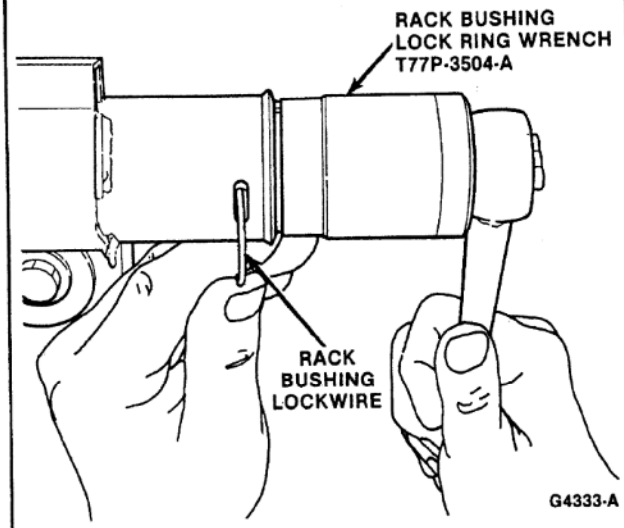
DISASSEMBLY AND ASSEMBLY

POWER STEERING GEAR

Assembly (Continued)

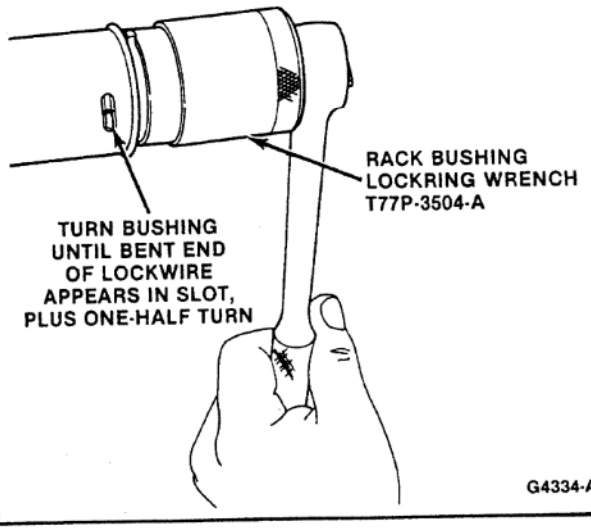
15. Remove the protective sleeve.

16. Using Rack Bushing Lock Ring Wrench T77P-3504-A, or equivalent, turn the rack bushing until the lockwire hole is visible through the slot in the housing. Insert the lockwire through the slot and position the bent end in the rack bushing hole.

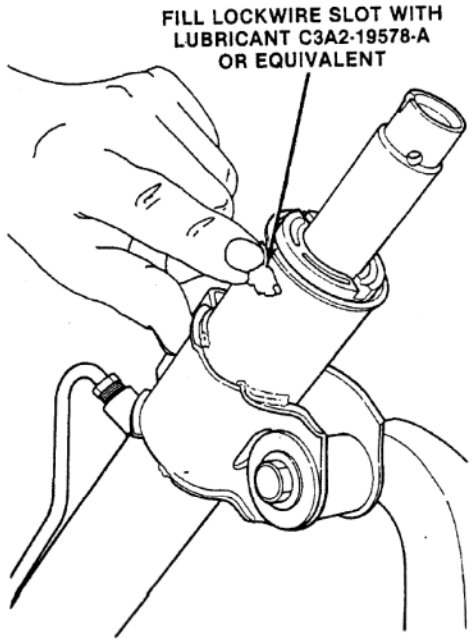


CAUTION: Make sure the bent end of the lockwire is fully seated in the end bushing so that it will not be distorted by the edge of the slot when the bushing is rotated.

17. Using the bushing wrench, turn the bushing clockwise one full turn until the lockwire is pulled completely into the housing. Then rotate the bushing an additional one-half turn to position the bent end of the lockwire 180° away from the slot.



18. Fill the lockwire slot with lubricant C3AZ-19578-A, or equivalent.

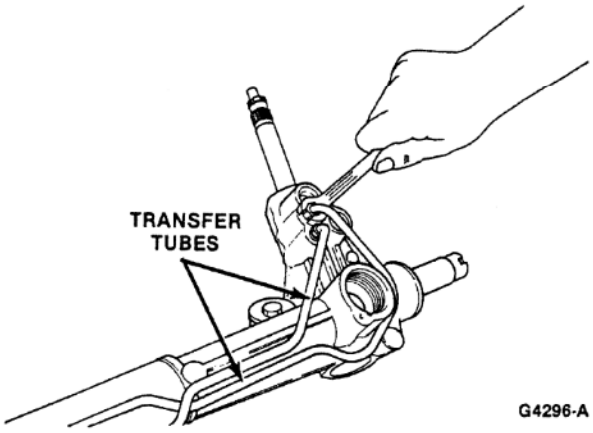


DISASSEMBLY AND ASSEMBLY

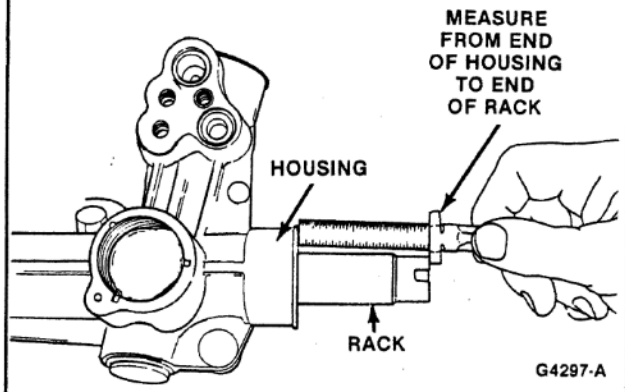
POWER STEERING GEAR

Assembly (Continued)

19. Install the transfer tubes.

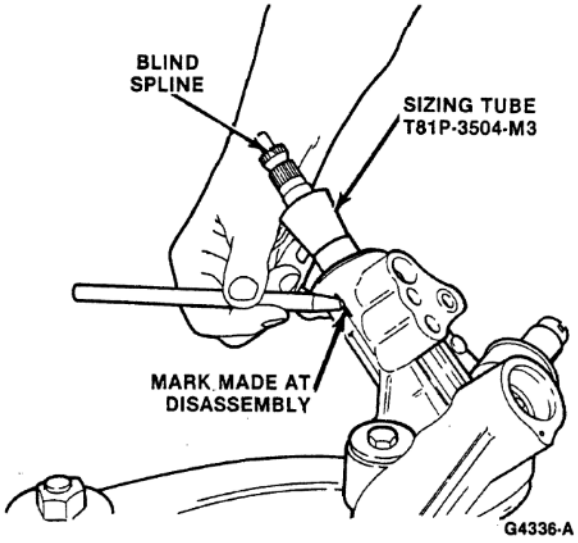


20. Position the rack in the housing until the pinion end of the rack extends from the housing the distance measured in Disassembly Step 11.



21. Install Sizing Tube T81P-3504-M3, or equivalent, in the top of the valve bore.

22. Lubricate the valve seals with automatic transmission fluid or power steering fluid and install the input shaft/pinion assembly in the housing. Make sure the input shaft blind spline is properly indexed with the alignment mark on the housing. Rotate the input shaft slightly from side to side to mesh the pinion with the rack.



23. Check for proper centering of the pinion as follows:

a. Turn the input shaft clockwise and count the number of turns required to reach the full-left-turn stop.

b. Return the pinion to the centered position.

c. Turn the input shaft counterclockwise and count the number of turns required to reach the full-right-turn stop.

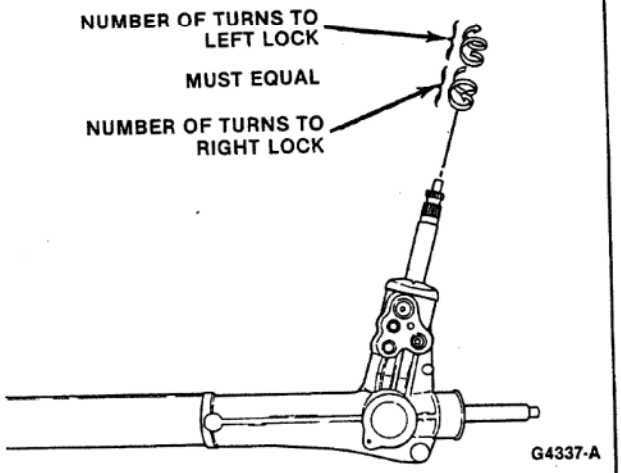
d. Return the pinion to the centered position.

DISASSEMBLY AND ASSEMBLY

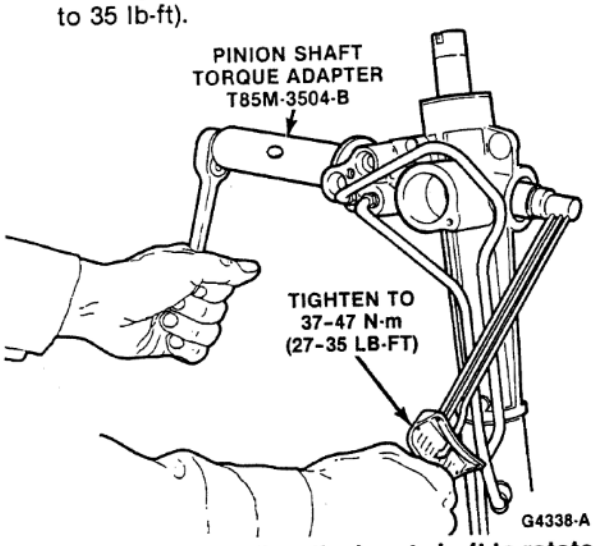
POWER STEERING GEAR

Assembly (Continued)

e. If the number of turns required to reach the turn stops are equal, the pinion is centered. If the number of turns are not equal, remove the pinion, re-center the rack, and re-index the pinion.

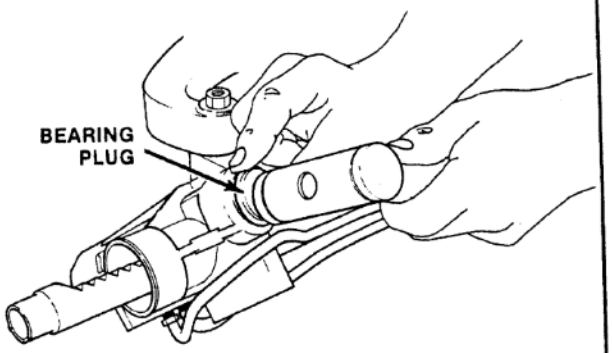


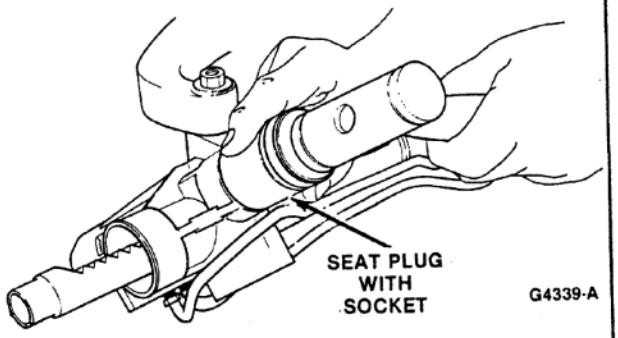
24. While holding the input shaft with Pinion Shaft Torque Adapter T85M-3504-B, or equivalent, install the pinion bearing locknut. Tighten the locknut to 37 to 47 N·m (27 to 35 lb-ft).



CAUTION: Do not allow the input shaft to rotate during installation of the locknut. Damage to the rack can occur if it is allowed to jam against either turn stop.

25. Install the pinion bearing bore plug. Start it squarely into the bore with a soft hammer, then seat it securely with a socket or other suitable adpater.



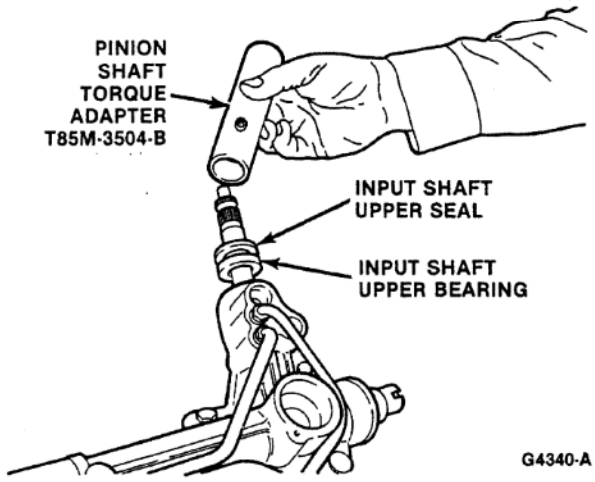


DISASSEMBLY AND ASSEMBLY

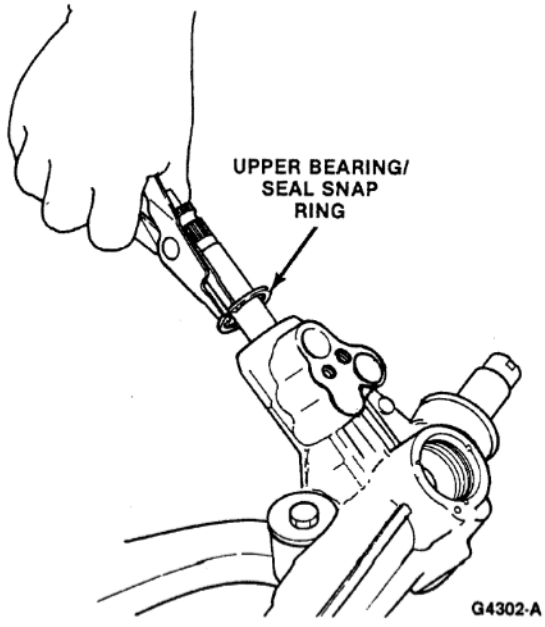
POWER STEERING GEAR

Assembly (Continued)

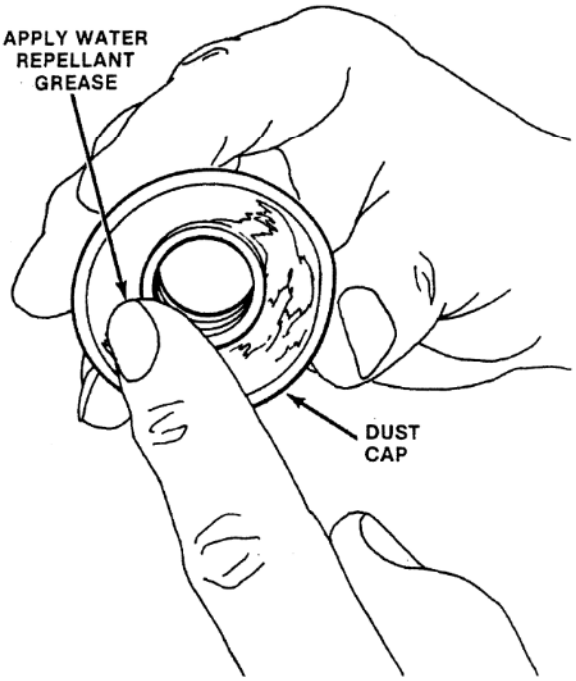
26. Lubricate the input shaft upper seal lip and install the upper bearing and seal on the shaft and into the housing, using Pinion Shaft Torque Adapter T85M-3504-B, or equivalent. Be sure the seal lip faces into the bore.

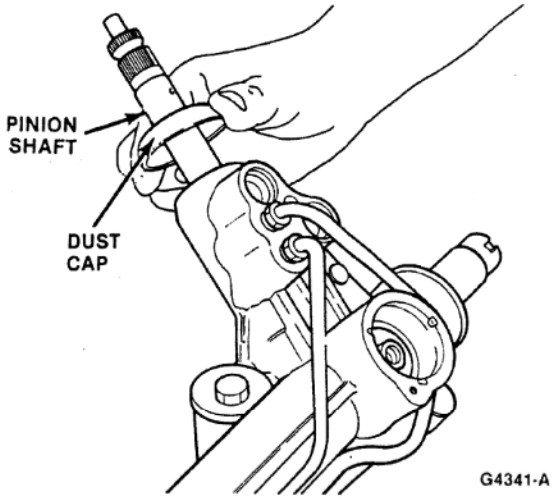


27. Install the pinion upper bearing and seal retaining snap ring.



28. Fill the space above the upper seal and inside the dust cover with a water-repellent grease. Install the dust cover.



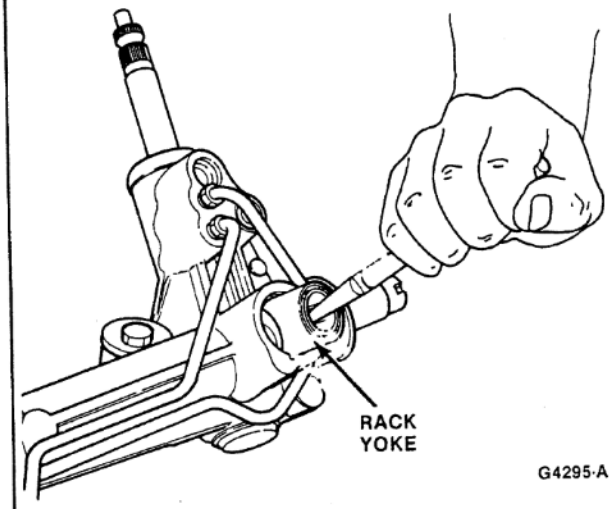


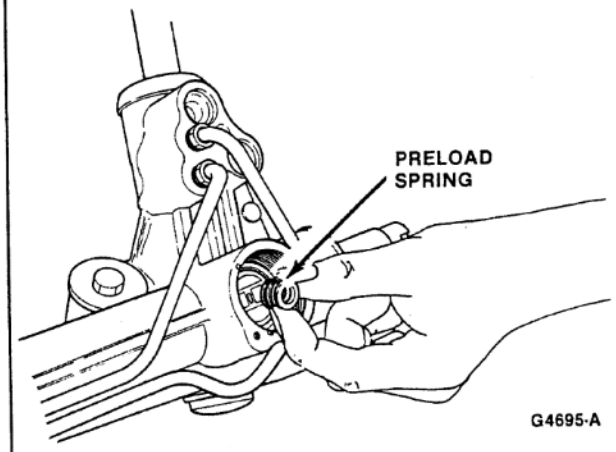
DISASSEMBLY AND ASSEMBLY

POWER STEERING GEAR

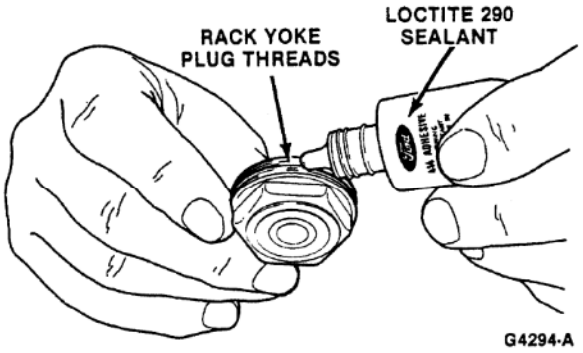
Assembly (Continued)

29. Coat the rack yoke bore and the rack yoke with Lubricant C3AZ-19578-A, or equivalent. Install the rack yoke and preload spring.

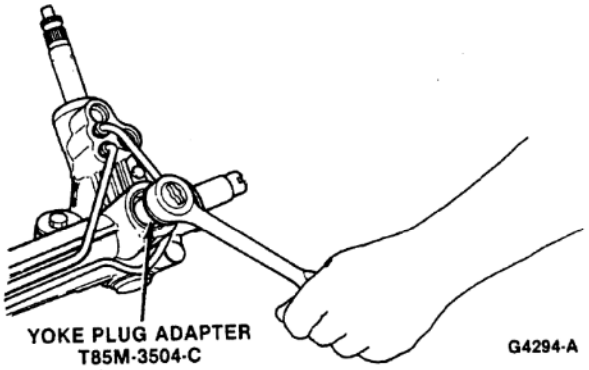




30. Coat the rack yoke plug threads with Loctite 290 penetrating grade anerobic sealant, or equivalent.



31. Install the plug, using Yoke Plug Adapter T85M-3504-C, or equivalent. Do not tighten the plug.



32. Adjust the rack preload. If necessary, refer to the procedure in this section.

33. Install the ball joint and tie rod assemblies. If necessary, refer to the procedure in this section.

34. Install the dust boots. If necessary, refer to the procedure in this section.

35. Install the tie rod ends. If necessary, refer to the procedure in this section.

SECTION 13-48 ZF Power Steering Gear

SUBJECT	PAGE
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DIAGNOSIS	
External Leakage	13-48-4
DISASSEMBLY AND ASSEMBLY	
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REMOVAL AND INSTALLATION (Cont'd.)	
Rack Mounting Bushing	13-48-9
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Tie Rod	13-48-9
Tie Rod End	13-48-7
SPECIAL SERVICE TOOLS	13-48-18
SPECIFICATIONS	13-48-18

DESCRIPTION

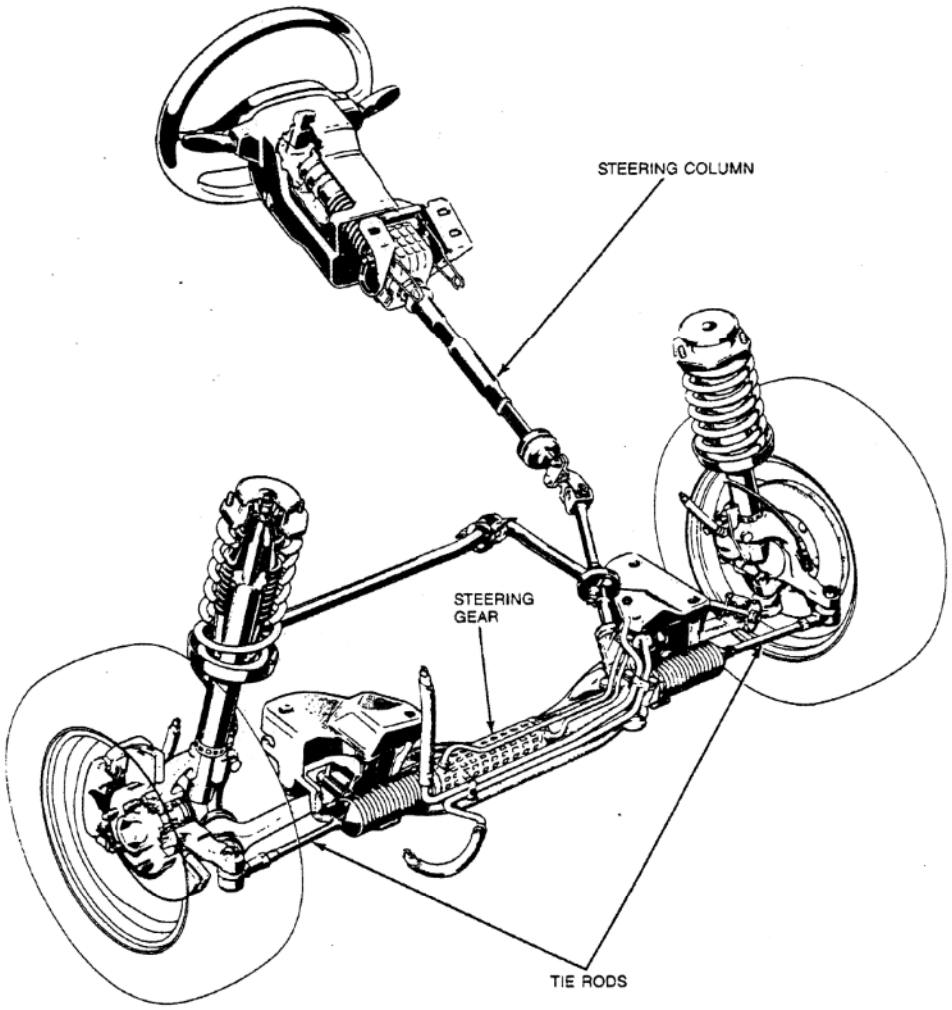
The 1986 and later XR4Ti are equipped with a "ZF" power assisted rack-and-pinion steering gear. The steering rack, in addition to connecting the front-wheel tie rod ends, is also a double-acting hydraulic cylinder. Power assist is provided by an open-center hydraulic system which supplies pressure equally to both ends of the rack cylinder. Rack cylinder end-to-end pressure remains in a balanced condition until driver input, through the steering wheel, tells the system a turn is called for. Then, the pressure supplied to one end of the rack cylinder is reduced, and system pressure on the other end assists the pinion in moving the rack until steering wheel input indicates the turn has been completed.

The hydraulic pressure is generated by a belt-driven pump mounted on the front of the engine. Fluid supply and return lines connect the pump to control valving which is part of the steering gear. Control valve action results from rotary motion and relative position of the input shaft, connected to the steering column and the pinion, in mesh with the rack. A torsion bar in the input shaft and pinion assembly centers the valve to supply balanced pressure to the rack cylinder when the steering wheel is not calling for a change of direction. When the wheel is turned, the torsion bar permits the pinion to lag behind the motion of the input shaft, shifting the valve to an unbalanced pressure condition, which in turn transmits unequal pressures to opposing sides of the rack piston. When the rack has moved to the desired position, indicated by pinion (and steering wheel) position, the torsion bar restores the valving to the centered, balanced condition. Power assist stops when control valving is centered.

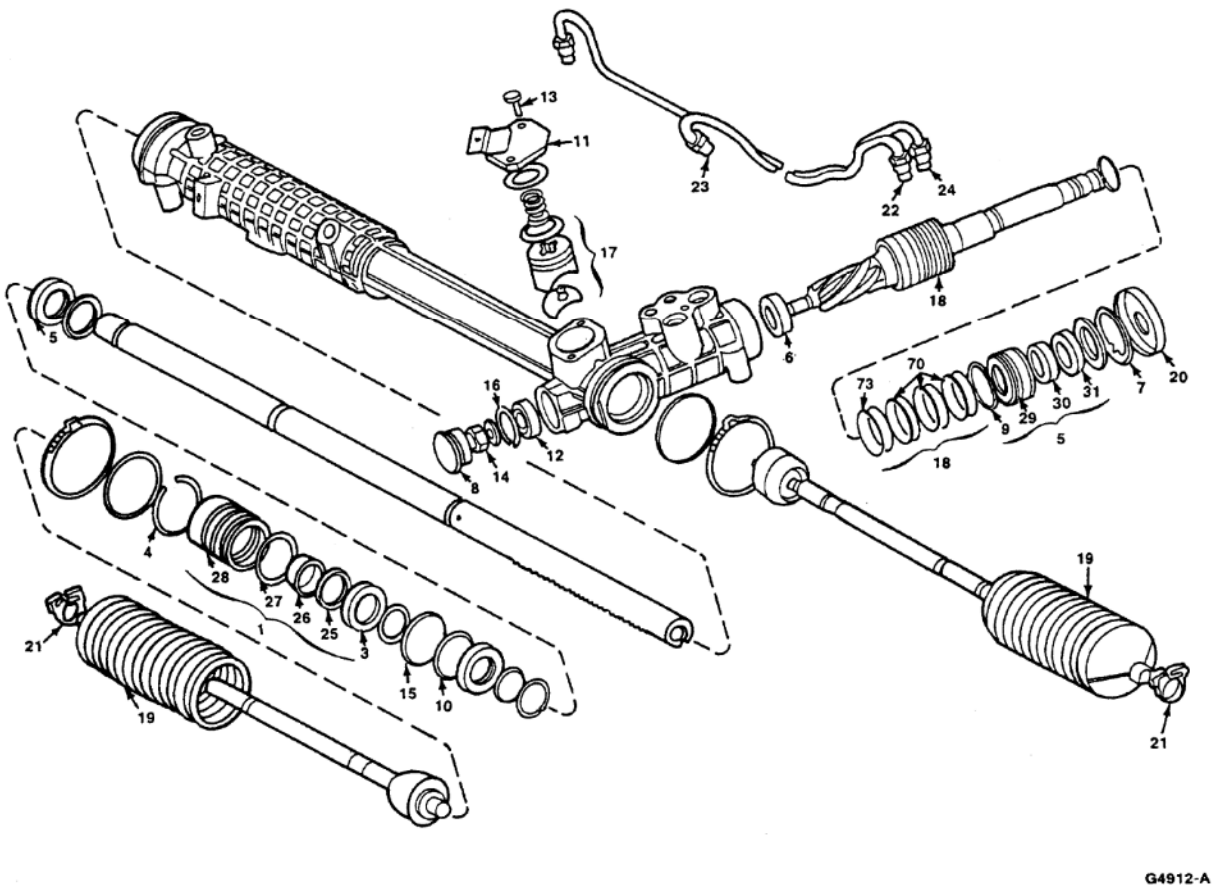
The action of the system is reversible, in that the self-centering or "caster" effect of the front-wheel geometry will actuate the valving through the pinion when the steering wheel is released.

In effect, the return to straight-ahead is also power assisted for desirable steering "feel."

DESCRIPTION (Continued)



DESCRIPTION (Continued)



DESCRIPTION (Continued)

LIST OF PARTS AVAILABLE FOR SERVICE — ZF POWER STEERING GEARS

Drawing Identification Number	Name	Drawing Identification Number	Name
1	Bearing & Seal Assy.	24	Tube Assy. — Pwr. Stng. Cyl. — Outer
3	Seal	25	Spacer
4	Retainer — Pwr. Stng. Cyl. Seal	26	Bearing Bush
5	Bearing & Seal Assy.	27	O-Ring 34 x 3
6	Seal — Stng. Gear Pinion Oil	28	Support Bush
7	Retainer Ring — Int. 39	29	Bush
8	Cap — Pwr. Stng. Gr. Pinion Lwr. Brg.	30	Needle Bearing
9	O-Ring — 33 x 2.5	31	Seal
10	O-Ring 33 x 1.5	65	Needle Bearing
11	Cover — Stng. Gear Housing	66	Bearing
12	Bearing — Power Stng. Gear Pinion Shaft	67	Pinion
13	Screw	69	Torsion Bar
14	Nut — Hex P/T Mtl. O Mio.	70	Sealing Ring
15	Sealing Ring — Piston	71	O-Ring
16	Retainer Ring — Int. 28	72	Pin
17	Yoke Assy.	73	O-Ring
18	Valve & Pinion Assy.	74	Valve Body
19	Boot — Stng. Gear B'Joint	75	Input Shaft
20	Cap — Pwr. Stng. Input Shaft	77	Pin
21	Hose Clamp — Plastic	78	Retaining Ring
22	Tube Assy. — Pwr Stng. Cyl. — Inner	80	Pin
23	O-Ring 5 x 2		

CG4913-A

DIAGNOSIS

External Leakage

When looking for leaks, use this procedure to pinpoint the exact cause and location to avoid an incorrect diagnosis:

1. Check for overfilled power steering pump reservoir.
2. Wipe suspected area dry.
3. Check for power steering pump overflow and aeration.
4. Check for exact source of oil. Example: Oil may be running down from another area (engine, etc.) and the drip may not be the leak point.
5. Some leaks are high-pressure leaks and may require holding steering wheel against stops to seep out.

   CAUTION: Do not hold the steering wheel against either stop for more than three to five seconds at a time. Cycle the steering wheel from stop-to-stop 10 times and check for leaks. The bellows may have to be moved back from the housing to see the leak.

DIAGNOSIS (Continued)

6. Power steering gear assembly leaks fall into several categories as listed in the Leakage Diagnosis chart. Leak category determines whether a component or the complete rack-and-pinion assembly must be replaced.

FORD INTEGRAL POWER RACK AND PINION STEERING GEAR

CONDITION	POSSIBLE SOURCE	ACTION
• **Hissing Sound** There is some noise in all power steering systems. One of the most common is a hissing sound most evident at standstill parking. There is no relationship between this noise and the performance of the steering gear.	• Hiss may be expected when the steering wheel is at the end of travel or when turning at standstill.	• Hiss is a normal characteristic of rotary steering gears and in no way affects steering. Do not replace the rack assembly unless the hiss is extremely objectionable. A replacement rack will also exhibit a slight noise and is not always a cure for the condition. Investigate for a grounded column or a loose boot at the dash panel. Any metal to metal contact will transmit valve hiss into the passenger compartment through the steering column. Verify clearance between flexible coupling components. Ensure steering column shaft and gear are aligned so flexible coupling rotates in a flat plane and is not distorted as shaft rotates.

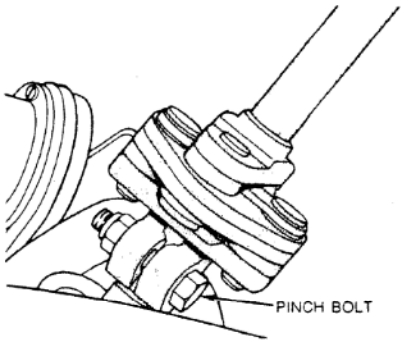
CG4805-A

REMOVAL AND INSTALLATION

Steering Gear

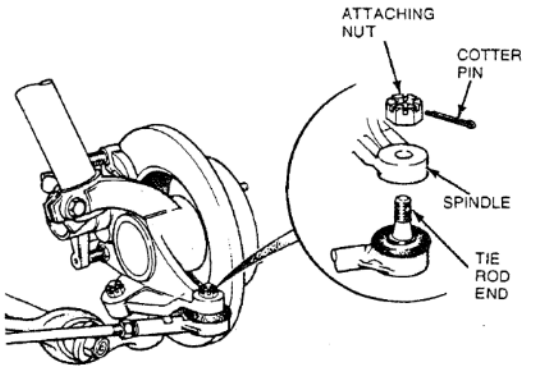
Removal

1. Turn steering wheel to straight-ahead position.
2. Raise vehicle on a hoist. Refer to Section 50-04.
3. Remove lower pinch bolt securing flex coupling to steering gear pinion shaft.



G4784-A

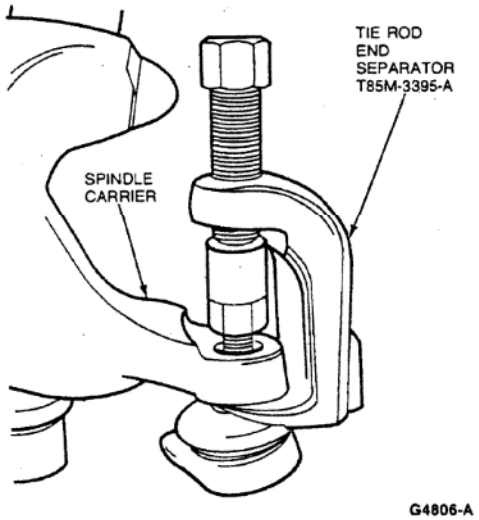
4. Remove cotter pins and nuts attaching tie rod ends to spindle carriers.



F4395-A

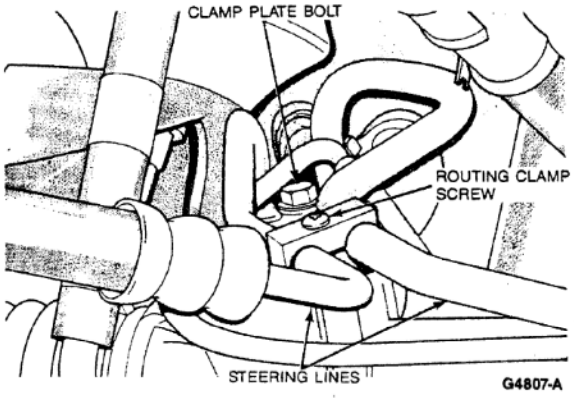
REMOVAL AND INSTALLATION (Continued)

5. Separate tie rod ends from spindle carriers using Tie Rod End Separator T85M-3395-A or equivalent.

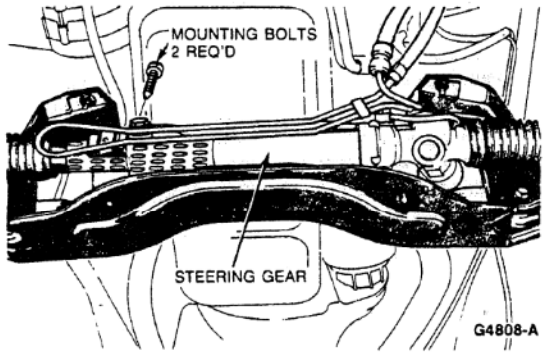


6. Position a drain pan under steering gear. Disconnect pressure and return power steering lines from steering gear by removing routing clamp screw and clamp plate bolt securing pump line plate assembly to gear housing. Pull assembly free. Allow power steering fluid to drain from steering lines into drain pan. Plug housing ports and steering lines to prevent entry of contaminants.

   NOTE: Discard all O-rings after removal.



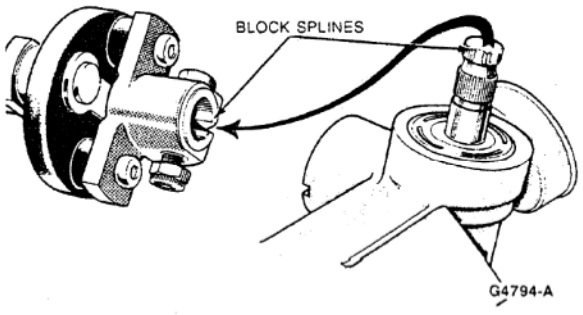
7. Remove two bolts retaining steering gear to engine front crossmember and steering gear assembly.
8. Remove rack mounting bushing if required. Refer to procedure in this Section.



Installation

1. Position steering gear assembly on engine front crossmember. Install two retaining bolts. Tighten bolts to 15 N·m (11 lb-ft), then an additional one-quarter turn. Refer to illustration under Removal, Step 7.
2. Remove plugs from gear housing ports and steering lines.
3. Install new O-rings on power steering pressure and return lines.
4. Position power steering pressure and return lines on steering gear. Install retaining routing clamp screw and clamp plate bolt. Tighten clamp plate bolt to 0.8-1.2 N·m (0.6-0.9 lb-ft).
5. Install tie rod ends to spindle carriers. Install attaching nuts and cotter pins. Tighten attaching nuts to 25-30 N·m (19-22 lb-ft).
6. Install steering column coupling shaft onto steering gear pinion shaft. Install pinch bolt securing flex coupling. Tighten pinch bolt to 25-30 N·m (19-22 lb-ft). Refer to illustration under Removal, Step 3.

   NOTE: Ensure block splines on coupling and steering gear pinion shaft are correctly aligned.



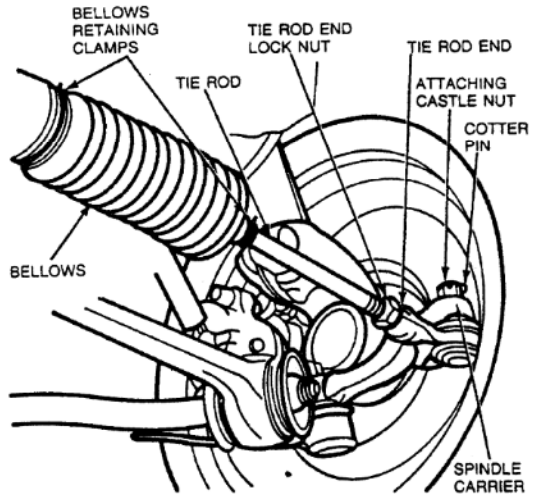
REMOVAL AND INSTALLATION (Continued)

7. Fill power steering reservoir and bleed as follows:
   a. Disconnect electrical connector from coil. Crank engine (two-second intervals) while slowly turning steering wheel from lock-to-lock three or four times.
   b. Check fluid level in power steering reservoir and ensure air bubbles no longer appear. Top off as required.

      NOTE: If air bubbles still appear in fluid reservoir, repeat Step a.
   c. Connect electrical connector to coil. Start engine and turn steering wheel from lock-to-lock three or four times.
   d. Turn engine off.
   e. Check power steering fluid level and steering gear for leaks.
8. If tie rod end locknuts were loosened, check and adjust front end alignment. Refer to Section 14-01.

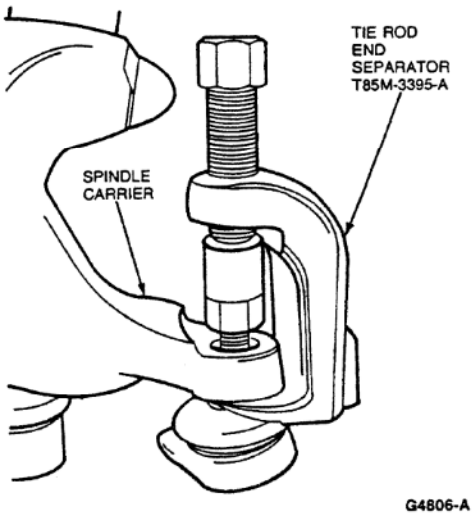
Tie Rod End

Removal



G4809-A

1. Remove cotter pin and nut attaching tie rod end to spindle carrier.
2. Separate tie rod end from spindle carrier using Tie Rod End Separator T85M-3395-A or equivalent.



G4806-A

3. Loosen tie rod end locknut.
4. Remove tie rod end from tie rod.

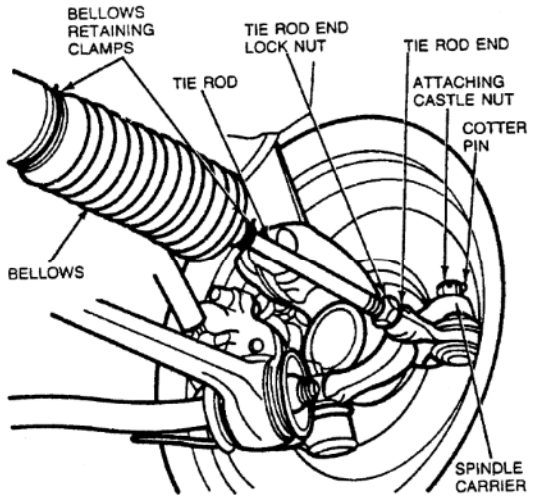
Installation

1. Install tie rod end on tie rod.
2. Tighten tie rod end locknut to 57-68 N·m (42-50 lb-ft).
3. Install tie rod end on spindle carrier. Install attaching nut and cotter pin. Tighten attaching nut to 25-30 N·m (19-22 lb-ft).
4. Adjust front end alignment. Refer to Section 14-01.

REMOVAL AND INSTALLATION (Continued)

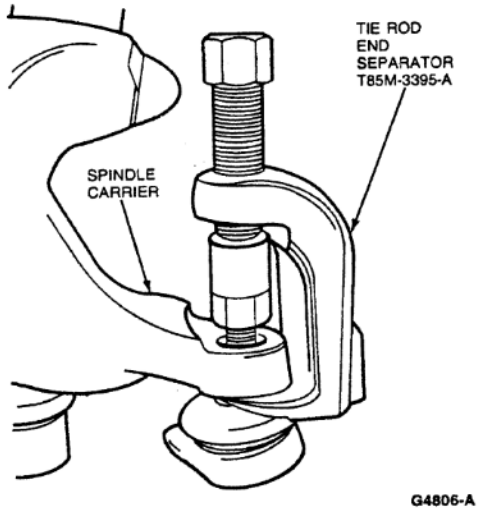
Bellows

Removal



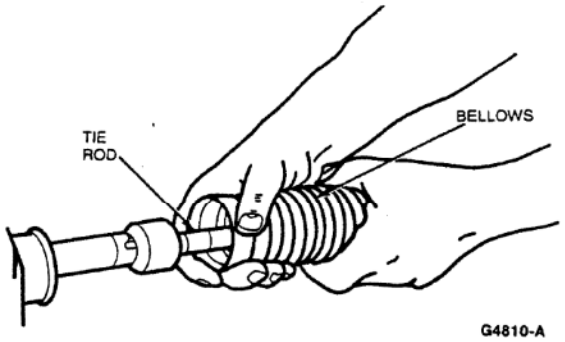
G4809-A

1. Remove cotter pin and nut attaching tie rod end to spindle carrier.
2. Separate tie rod end from spindle carrier using Tie Rod End Separator T85M-3395-A or equivalent.



G4806-A

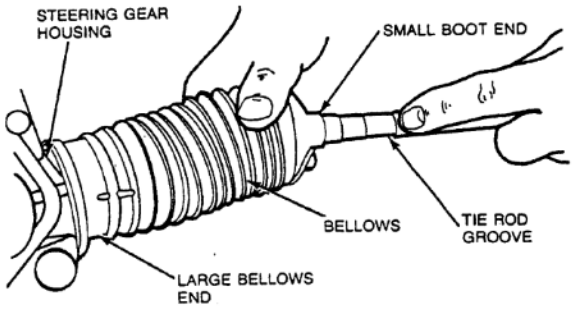
3. Remove tie rod end as outlined.
4. Remove bellows clamps.
5. Carefully pull bellows over tie rod and remove.



G4810-A

Installation

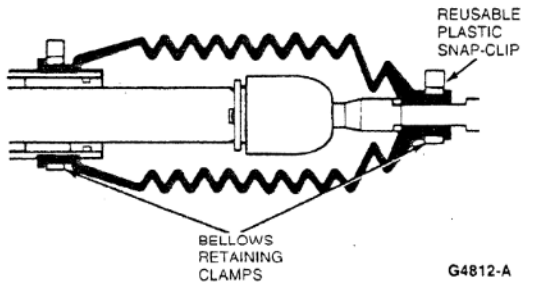
1. Position large bellows clamp over steering housing end.
2. Spray end of tie rod with Silicone Lubricant D7AZ-19553-A or equivalent to aid in installation of bellows. Install bellows.
3. Ensure small end of bellows is properly seated in tie rod groove and large end of bellows is properly seated around steering gear housing.



G4811-A

REMOVAL AND INSTALLATION (Continued)

4. Install large bellows clamp over large bellows end and small bellows clamp over small bellows end.

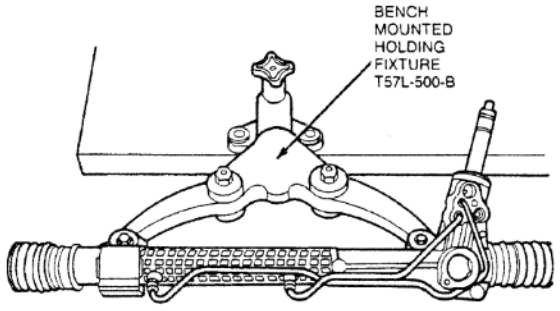


5. Install tie rod end as outlined. Tighten to 57-68 N·m (42-50 lb-ft).
6. Install tie rod end on spindle carrier. Install attaching nut and cotter pin. Tighten attaching nut to 25-30 N·m (19-22 lb-ft). Refer to illustration under Removal, Step 2.
7. Adjust front end alignment. Refer to Section 14-01.

Tie Rod

Removal

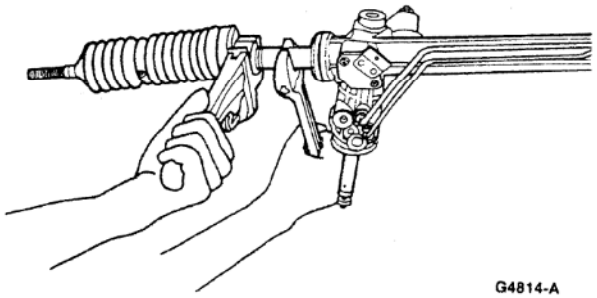
1. Remove steering gear as outlined.
2. Attach steering gear to Bench Mounted Holding Fixture T57L-500-B or equivalent.



3. Remove tie rod ends and bellows as outlined.
4. Rotate input shaft until rack teeth extend from side of housing.
5. Grip rack teeth with an adjustable wrench or place in a vise equipped with protective jaw caps to prevent rotation of rack.

CAUTION: The rack must be held against turning to prevent damage to the pinion. If not held in this manner, the twisting force applied to the rack during ball joint removal could damage the pinion.

6. Remove ball joint/tie rod assemblies using a pipe wrench.



NOTE: The ball joint and tie rod cannot be disassembled. They are serviced only as an assembly.

Installation

1. Install ball joint/tie rod assemblies.
2. Ensure rack is secured against rotation and coat the threads of the tie rod with Loctite 270. Tighten ball joint housing to 72-88 N·m (53-65 lb-ft).
3. Remove steering gear from Bench Mounted Holding Fixture T57L-500-B or equivalent.
4. Install bellows and tie rod ends as outlined.
5. Install steering gear as outlined.
6. Adjust front end alignment. Refer to Section 14-01.

Rack Mounting Bushing

Removal

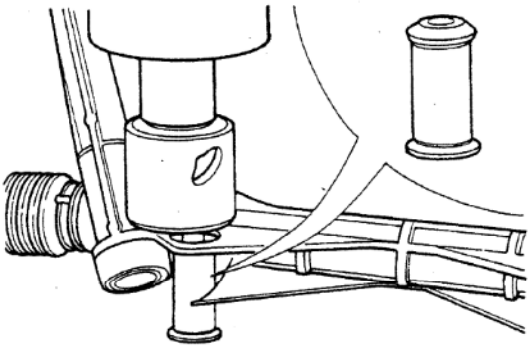
CAUTION: Rack mounting bushings may be damaged during removal and cannot be reused.

NOTE: Bushings can be pressed out in either direction.

1. Remove steering gear assembly. Refer to procedure in this Section.
2. Carefully position steering gear in a press. Using a suitable tool, press out old bushing.

REMOVAL AND INSTALLATION (Continued)

3. Repeat for other bushing.

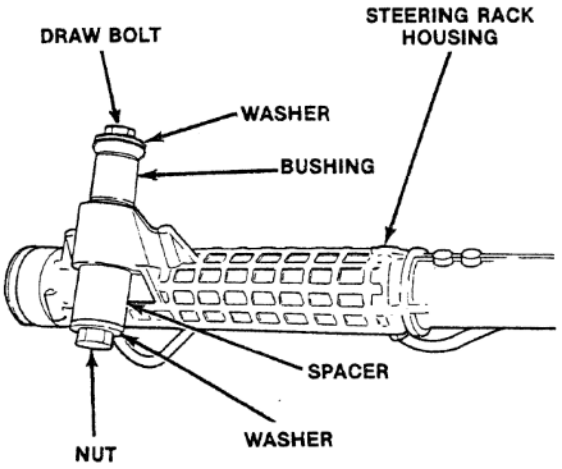


G6502-A

Installation

1. Make sure bushing bores in rack housing are clean and free of nicks or burrs.
2. Lightly lubricate the new bushings.
3. Position new bushing with draw bolt (or threaded rod), two washers, suitable spacer (or socket) and a nut as shown.

   NOTE: Draw bolt used to install bushings must have enough threads to allow the bushing to be drawn all the way into the rack housing. When possible, use threaded rod.



G6503-A

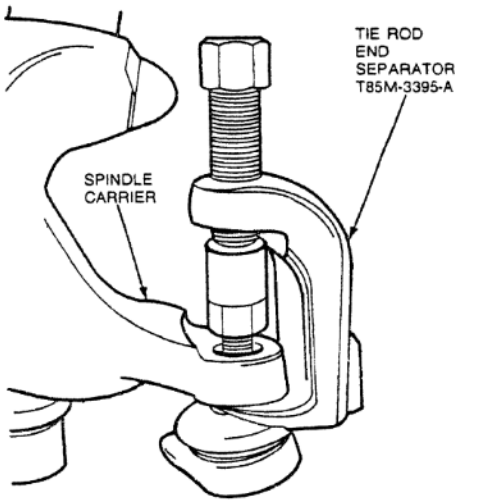
4. Tighten nut to draw new bushing into rack housing.
5. Remove nut, washers, spacer, and draw bolt.
6. Repeat procedure for other bushing.
7. Install steering gear assembly. Refer to procedure in this Section.

ADJUSTMENTS

Tie Rod Articulation Check

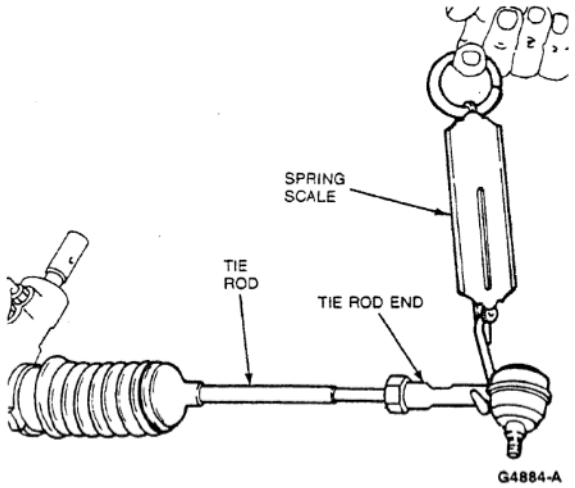
This check may be done on the vehicle.

1. Separate tie rod ends from spindle carriers using Tie Rod End Separator T85M-3395-A or equivalent.



G4806-A

2. Hook Spring Scale T74P-3504-Y or equivalent over tie rod end and measure the force required to move the tie rod.
3. If force required to move tie rods through a 300mm (11.8 inches) radius is not between 3.33N-33.3N (.75 lbs and 7.43 lbs), replace tie rod.



G4884-A

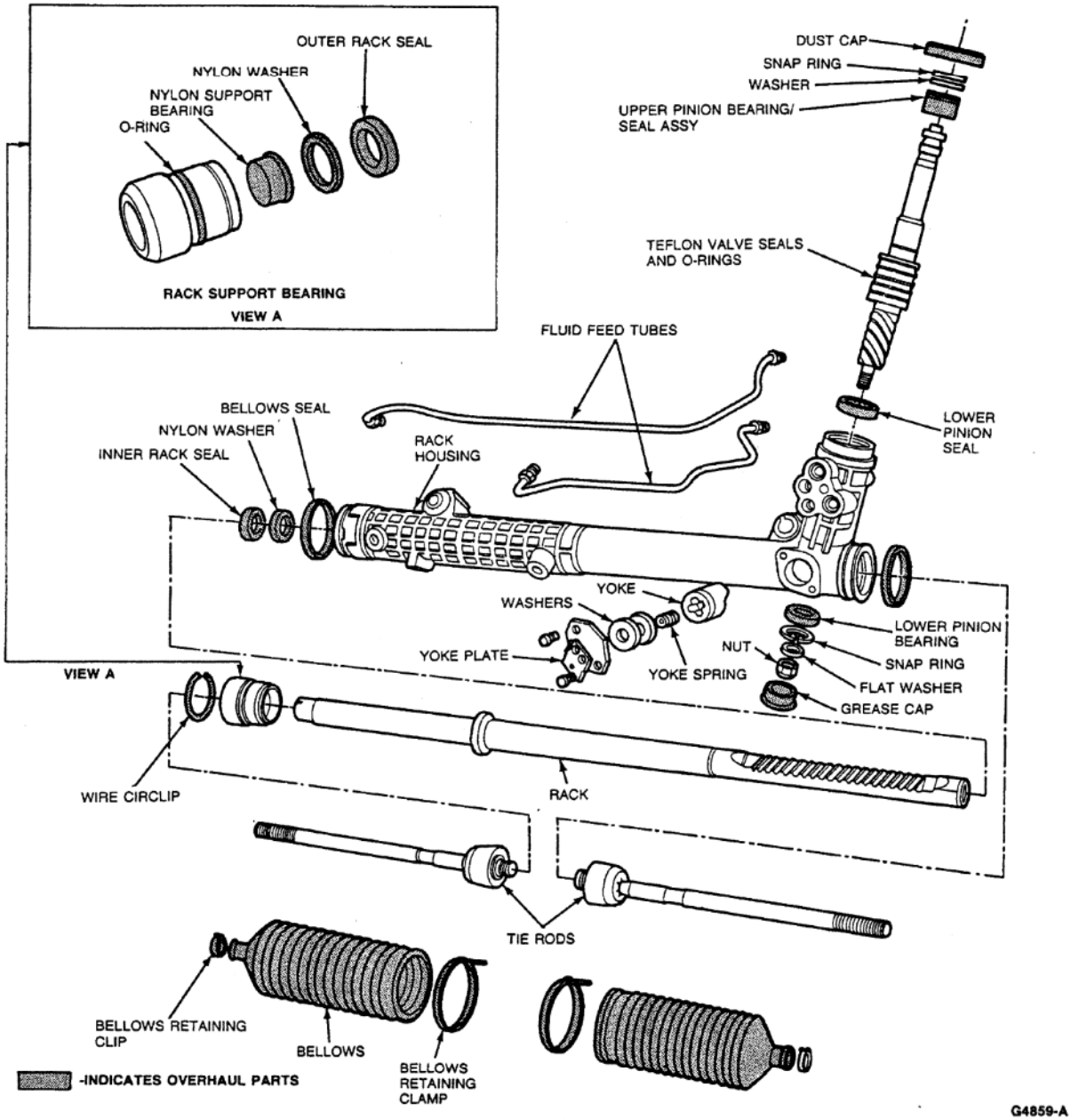
DISASSEMBLY AND ASSEMBLY

Steering Gear

Disassembly

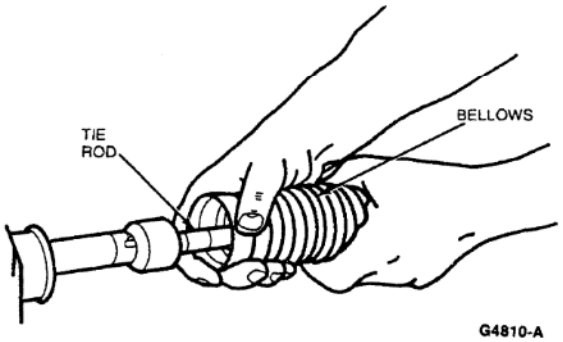
Use the following precautions when servicing steering gear:

- Use a clean workbench and tools.
- Thoroughly clean exterior of unit with solvent. Drain off excess hydraulic fluid.
- Handle all parts carefully to avoid nicks, burrs, scratches and dirt.
- Do not use solvent on seals.
- Impact tools must not be used during any disassembly or assembly procedures.



DISASSEMBLY AND ASSEMBLY (Continued)

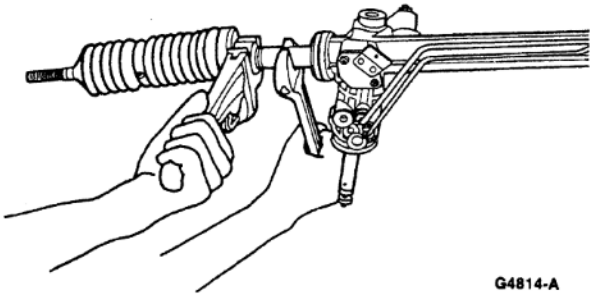
1. Remove steering gear as outlined.
2. Mount steering gear in Bench Mounted Holding Fixture T57L-500-B or equivalent.
3. Loosen tie rod end locknut.
4. Remove tie rod end from tie rod.
5. Remove bellows clamps.
6. Carefully pull bellows over tie rod and remove.



7. Slowly turn steering rack from lock-to-lock, draining fluid from pressure and return ports into a container.

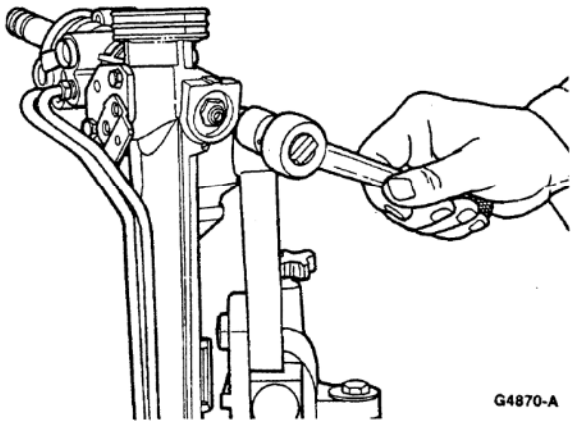
   CAUTION: The rack must be held against turning to prevent damage to the pinion. If not held in this manner, the twisting force applied to the rack during ball joint removal could damage the pinion.

8. Hold flat surface of rack with adjustable wrench or place in a vise equipped with protective jaw caps. Remove ball joint/tie rod assemblies using a pipe wrench.

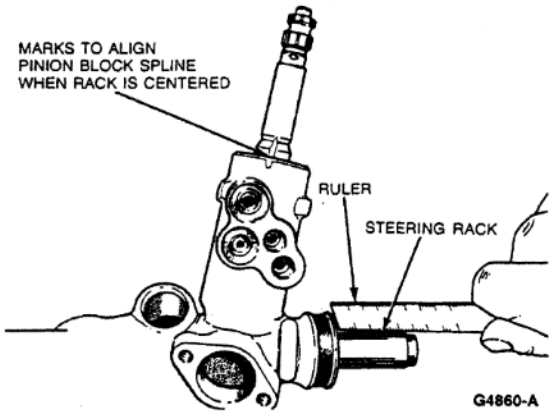


NOTE: The ball joint and tie rod cannot be disassembled. They are serviced only as an assembly.

9. Turn steering all the way to the LH lock (clockwise). Remove housing cap from lower pinion valve housing. Remove locknut and washer.

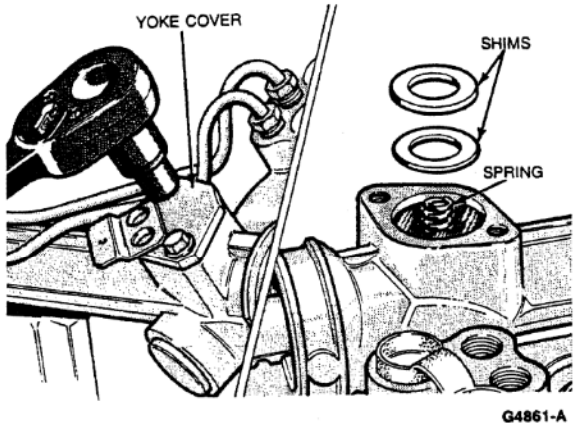


10. Centralize steering gear by turning lock-to-lock and halfway back again.
11. Using a ruler, measure distance steering rack projects out of pinion housing. Note this measurement. Also, note pinion block spline position in relation to pinion/valve housing and mark position.

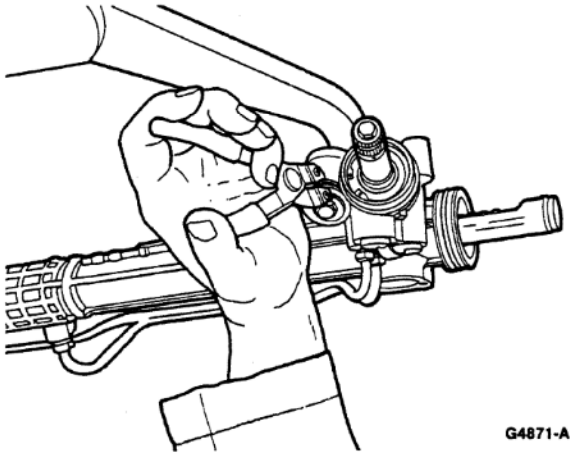


DISASSEMBLY AND ASSEMBLY (Continued)

12. Remove bolts securing yoke cover, shims and spring. Do not remove yoke at this time.

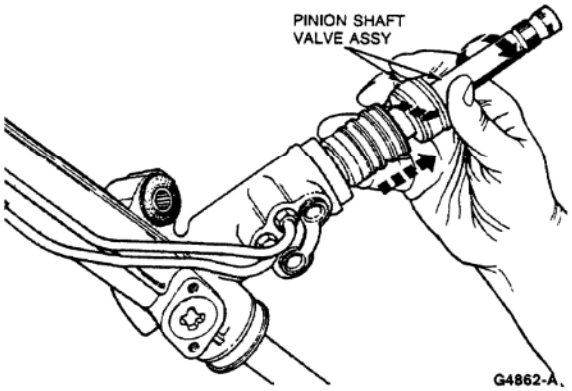


13. Remove dust cap. Using a pair of circlip pliers, remove upper pinion bearing circlip from pinion housing.

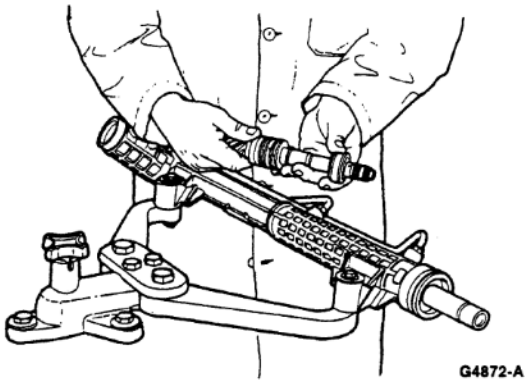


14. Remove pinion shaft and valve assembly from housing by pulling and twisting.

CAUTION: Care must be taken to prevent contaminants from entering valve body or sleeve valve.



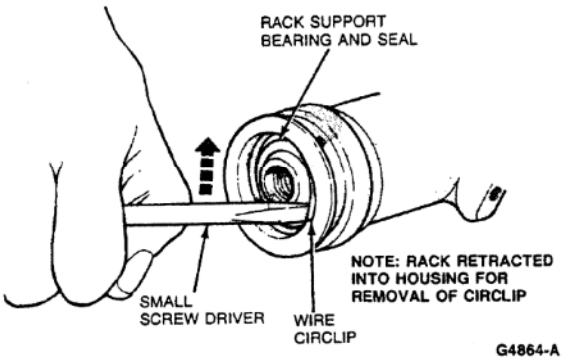
15. Slide oil seal and upper pinion bearing off input shaft.



CAUTION: Do not disassemble valve and pinion. These are set to specification as an assembly at the factory.

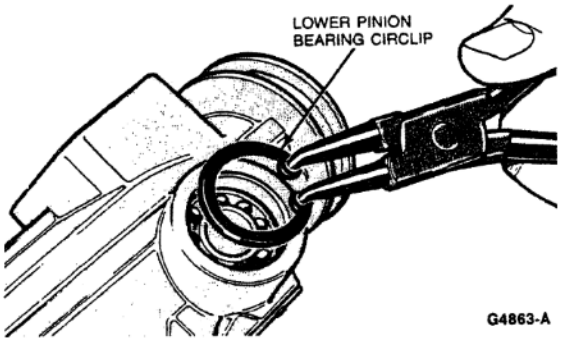
DISASSEMBLY AND ASSEMBLY (Continued)

16. Remove and discard all teflon seals. Remove and discard neoprene O-ring seal tensioners beneath teflon valve assembly seals.
17. Retract rack, and using a screwdriver, remove circlip retaining rack support bearing and seal.

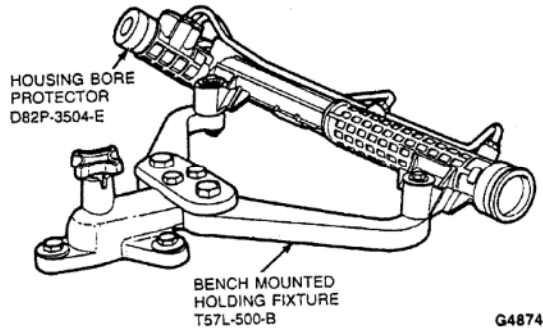


NOTE: The remaining steering fluid will be released during this procedure.

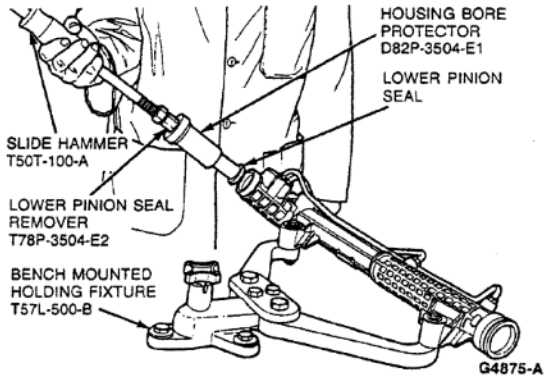
18. Remove steering rack with rack support bearing and seal from rack tube.
19. Using O-ring Tool T71P-19703-C or equivalent remove teflon ring and O-ring from rack assembly.
20. Remove lower pinion bearing circlip.



21. Using a soft punch, remove lower pinion bearing.
22. Install Housing Bore Protector D82P-3504-E1 or equivalent into rack housing.

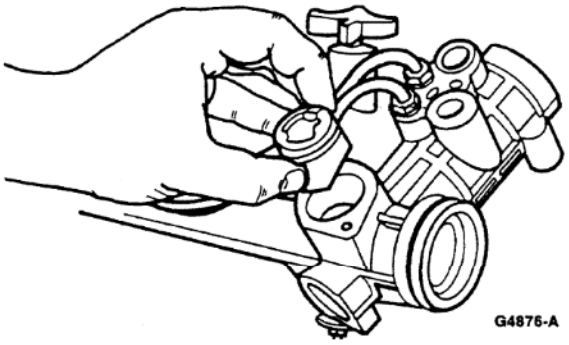


23. Using Lower Pinion Seal Remover T78P-3504-E2 and Impact Slide Hammer T50T-100-A or equivalent remove lower pinion valve seal from pinion housing.



DISASSEMBLY AND ASSEMBLY (Continued)

24. Push out yoke from valve housing.



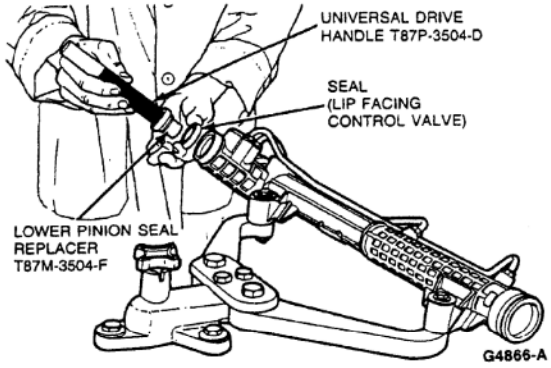
25. Carefully remove inner rack seal and nylon washer using a 3/4-inch socket and 18-inch extension to drive seal and nylon washer from steering rack (removed from end opposite of pinion).

CAUTION: Care must be taken not to damage inner seal surface of rack housing when seal and nylon washer are removed.

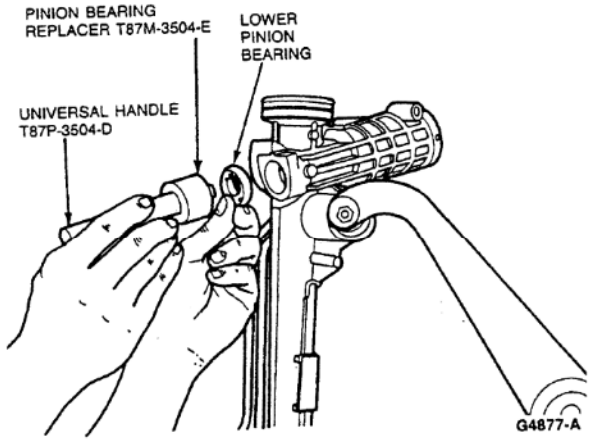
Assembly

CAUTION: Before assembly, clean and inspect all parts and seal contact areas.

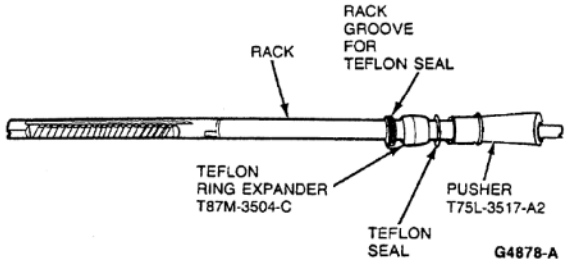
1. Using Universal Drive Handle T87P-3504-D and Lower Pinion Seal Replacer T87M-3504-F or equivalent install new lower pinion seal into pinion/valve housing with sealing lip facing control valve.



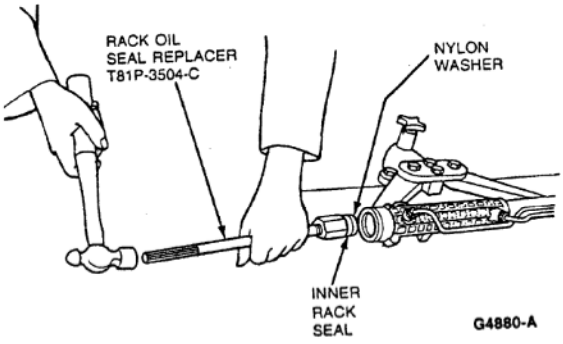
2. Using Universal Drive Handle T87P-3504-D and Lower Pinion Bearing Replacer T87M-3504-E or equivalent install lower pinion bearing into piston housing. Install retaining circlip.



3. Lubricate rack tube with power steering fluid. Install new O-ring onto rack. Using Teflon Ring Expander T87M-3504-C and Pusher T75L-3517-A2 or equivalent install rack piston teflon seal on steering rack.

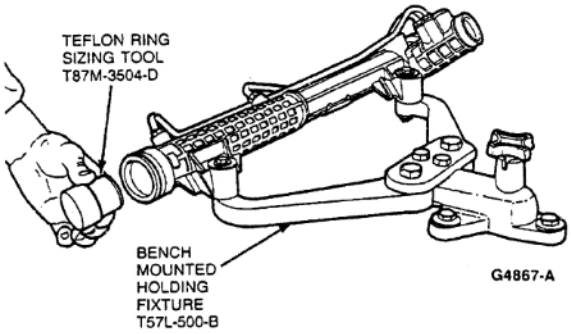


4. Using Rack Oil Seal Replacer T81P-3504-C or equivalent install inner rack seal and nylon washer into steering rack housing bore.

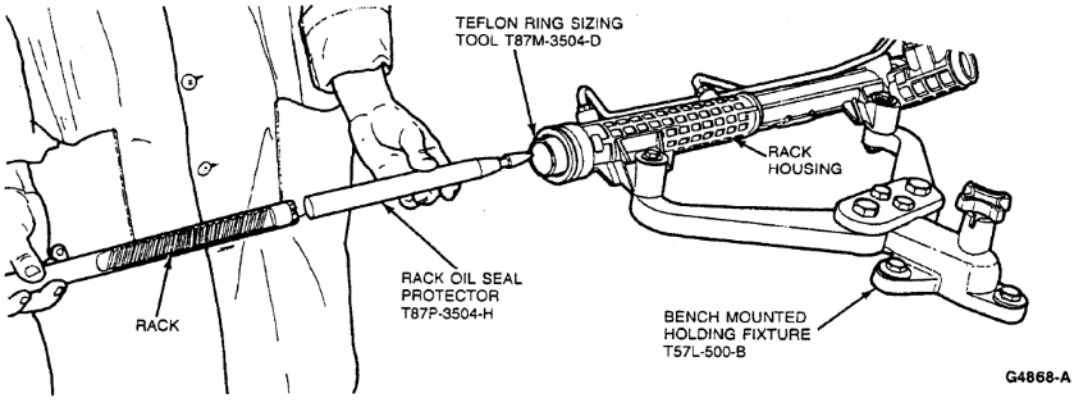


DISASSEMBLY AND ASSEMBLY (Continued)

5. Place Teflon Ring Sizing Tool T87M-3504-D or equivalent in end of rack housing to protect bore and size the teflon rack seal during rack installation.



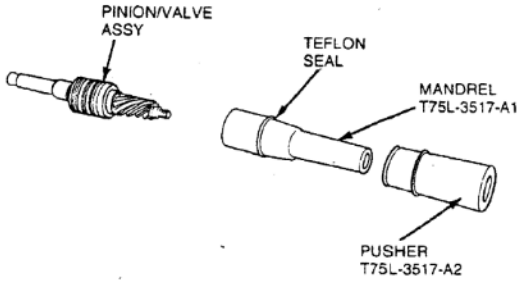
6. Place Rack Oil Seal Protector T87P-3504-H or equivalent on rack. Coat rack with power steering fluid and insert into rack housing. Ensure that rack teeth are properly aligned for pinion installation.
7. Remove Teflon Ring Sizing Tool T87M-3504-D and Rack Oil Seal Protector T87P-3504-H or equivalent.



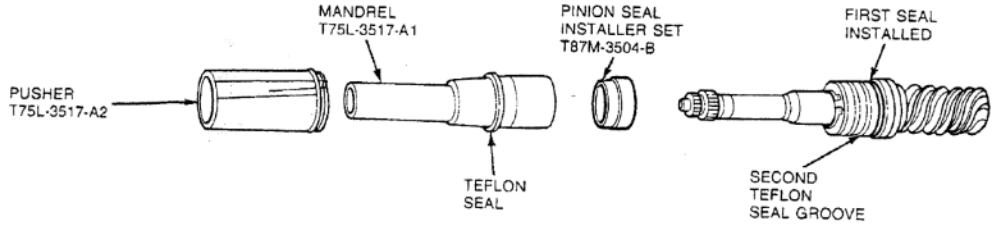
8. Install rack support bushing into rack housing. Install retaining wire clip.
9. Install O-rings on pinion valve assembly.
10. To install new teflon seals, mount end of pinion valve in a soft-jawed vise.
11. Lubricate Mandrel T75L-3517-A1 or equivalent with power steering fluid and install over pinion/valve assembly. Slide one teflon seal over tool.

DISASSEMBLY AND ASSEMBLY (Continued)

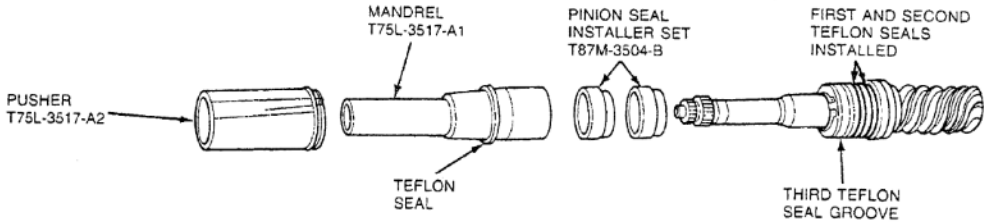
12. Slide Pusher T75L-3517-A2 or equivalent over mandrel, forcing the teflon seal down the ramp into the fourth groove of the pinion valve. Add a spacer to the inside of the mandrel for installation of the next teflon seal and repeat this step three times. By adding and rotating the spacers, the mandrel tool will line up the next groove of the pinion/valve assembly. For proper positioning of the spacers, refer to the following illustrations.



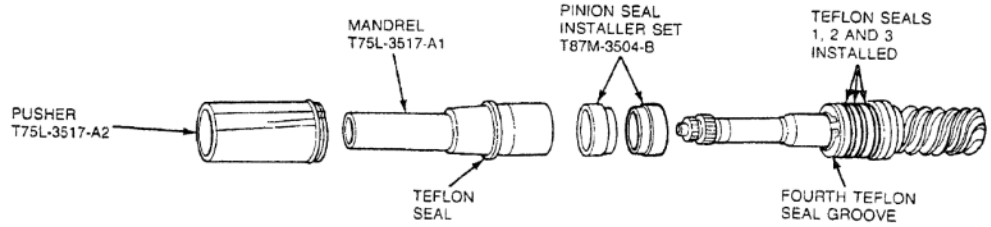
G4882-A



G4909-A

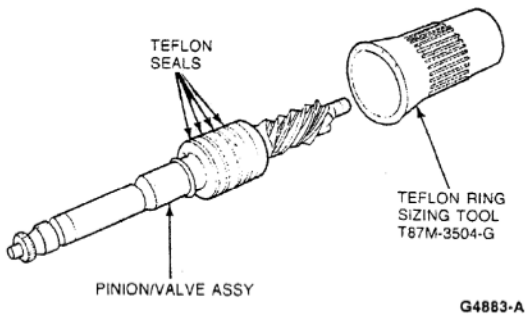


G4910-A



G4911-A

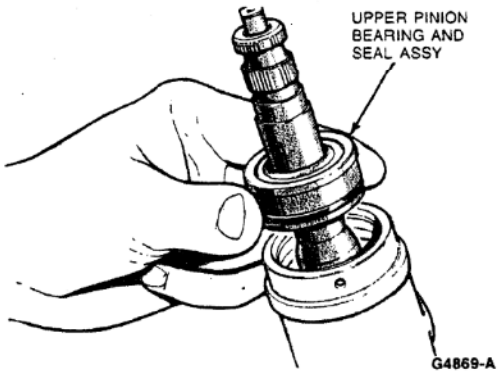
13. After installation of teflon seals use Teflon Ring Sizing Tool T87M-3504-G or equivalent to size teflon seals. Leave Teflon Ring Sizing Tool T87M-3504-G installed for 60 seconds to permit the teflon seals to fully settle.



G4883-A

DISASSEMBLY AND ASSEMBLY (Continued)

14. Center steering rack. Using Pinion Valve Teflon Seal Sizer T87M-3504-H as a bore protector, install pinion assembly into housing. Align pinion as noted in Disassembly, Step 11.
15. Slide upper pinion bearing and seal assembly onto pinion input shaft.
16. Install upper washer over pinion input shaft. Install retaining circlip and dust cap.
17. Install new O-ring on yoke. Install yoke, spring and original shims in pinion housing. Coat yoke cover plate with a thin film of sealing compound. Install cover plate and retaining screws. Tighten retaining screws to 7-8 N·m (5-6 lb-ft). Refer to illustration under Disassembly, Step 13.
18. Install flatwasher and locknut on pinion shaft. Tighten locknut to 15-20 N·m (11-15 lb-ft).
19. Fill dust cap and area around locknut with grease. Install dust cap on pinion housing.
20. Hold flat of rack with an adjustable wrench and install tie rod/ball joint assemblies. Tighten to 70-77 N·m (52-56 lb-ft).
21. Apply light coat of power steering fluid to rack teeth.
22. Apply a light coat of grease to steering rack bellows. Slide bellows over tie rods and rack housing. Install bellows retaining clamps.
23. Install tie rod end on tie rod. Tighten tie rod end locknut to 57-68 N·m (42-50 lb-ft).
24. Install steering gear as outlined.
25. Check and adjust steering fluid as required. Refer to Section 13-51.
26. Check and adjust front end alignment as required. Refer to Section 14-01.



G4869-A

SPECIFICATIONS

LUBRICANTS

Description	Ford Specification
Motorcraft Dexron®-II-Automatic Transmission Fluid	Dexron®-II

CG4485-A

DESCRIPTION	N·m	LB-FT
PINION SHAFT LOCKNUT	15-20	11-15
YOKE COVER PLATE RETAINING SCREWS	7-8	5-6
TIE ROD BALL JOINT	25-30	19-22
TIE ROD END LOCKNUT	57-68	42-50
STEERING GEAR TO HOLDING FIXTURE-NUTS	15	11
BALL JOINT HOUSING TO RACK	72-88	53-65

G6501-A

SPECIAL SERVICE TOOLS

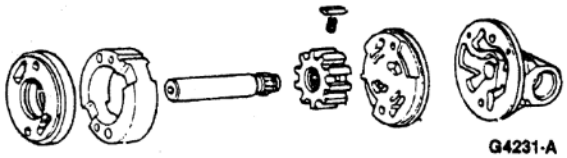
Tool Number	Description	Tool Number	Description
T50T-100-A	Slide Hammer	T85M-3395-A	Tie Rod End Separator
T57L-500-B	Bench Mounted Holding Fixture	T87P-3504-D	Universal Drive Handle
T71P-19703-C	O-Ring Tool	T87M-3504-B	Pinion Seal Installer Set
T74P-3504-Y	Spring Scale	T87M-3504-C	Teflon Ring Expander
T75L-3517-A	Seal Installation Set	T87M-3504-D	Teflon Ring Sizing Tool
T75L-3517-A1	Mandrel	T87M-3504-E	Pinion Bearing Replacer
T75L-3517-A2	Pusher	T87M-3504-F	Lower Pinion Seal Replacer
T78P-3504-E2	Lower Pinion Seal Remover	T87M-3504-G	Teflon Ring Sizing Tool
D82P-3504-E1	Housing Bore Protector	T87P-3504-H	Rack Oil Seal Protector
T81P-3504-C	Rack Oil Seal Replacer		

CG4914-A

SECTION 13-51 POWER STEERING PUMP

CONTENTS

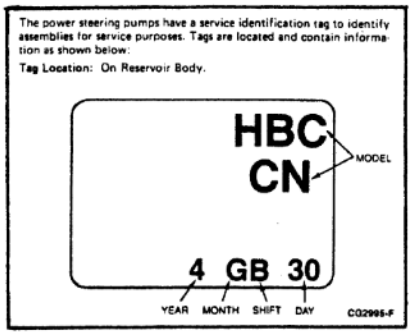
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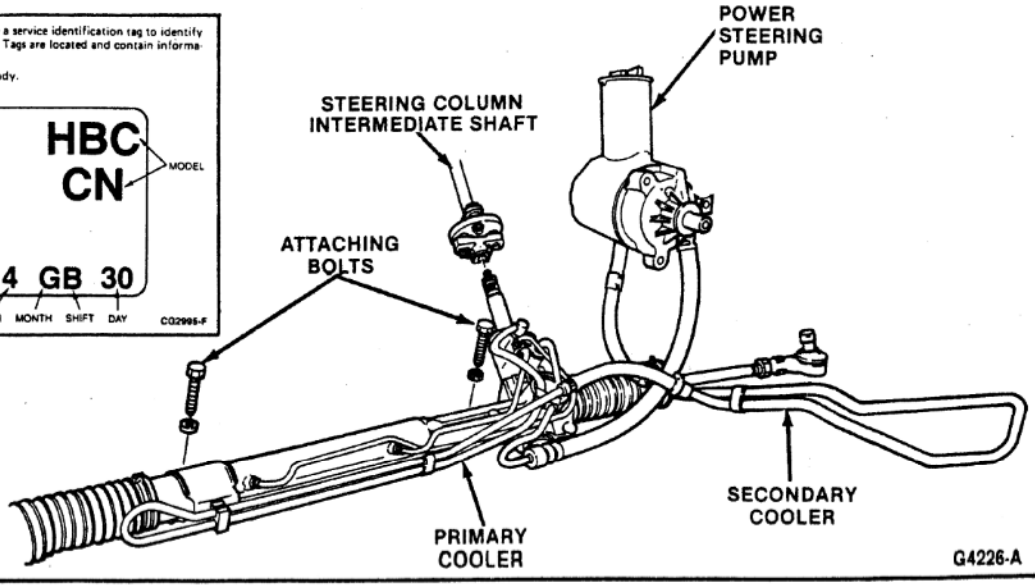

G4231-A

DESCRIPTION

GENERAL INFORMATION

The Ford Model CII pump supplies the hydraulic flow needed to operate the XR4Ti power steering system. The pump is bracket mounted on the left side of the engine just below the alternator and shares a common dual belt drive with the alternator. The drive belts are the cogged "V" type with the tension adjustment provided at the alternator mounting bolts. The pump is completely serviceable. After disassembly, cleaning and inspection, the internal and external components can be replaced if damaged or worn. A pressure-sensitive identification tag is attached to the pump reservoir. This tag indicates the basic model number (HBC) and the part number suffix. **Because internal differences may exist between pump models, always use the model codes given on the tag when ordering service parts.**

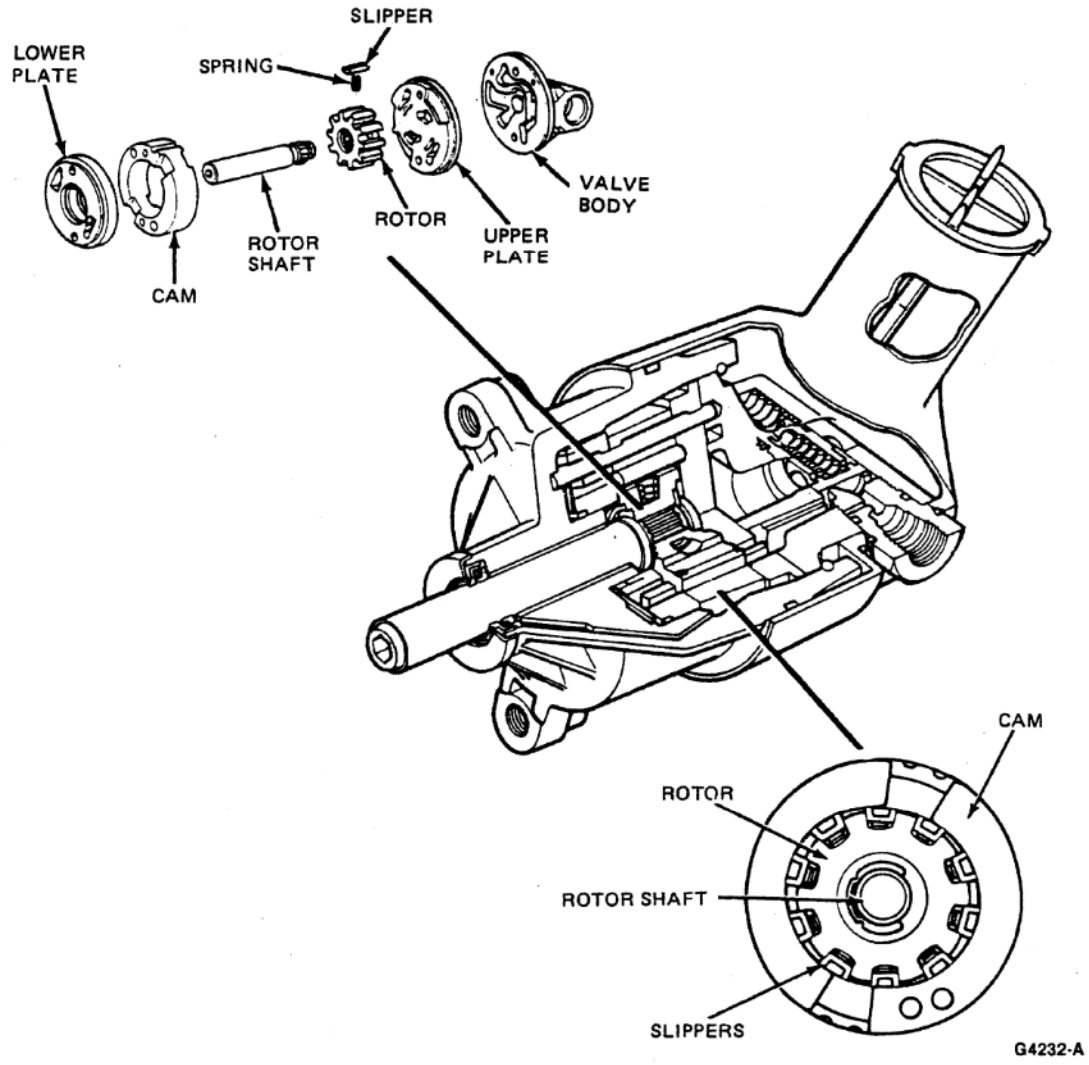




G4226-A

DESCRIPTION

PUMP OPERATION



Power steering is a hydraulically operated system that greatly reduces the amount of effort required to turn the steering wheel. The system consists of a rack and pinion steering gear, a belt driven pump and the necessary interconnecting hydraulic lines.

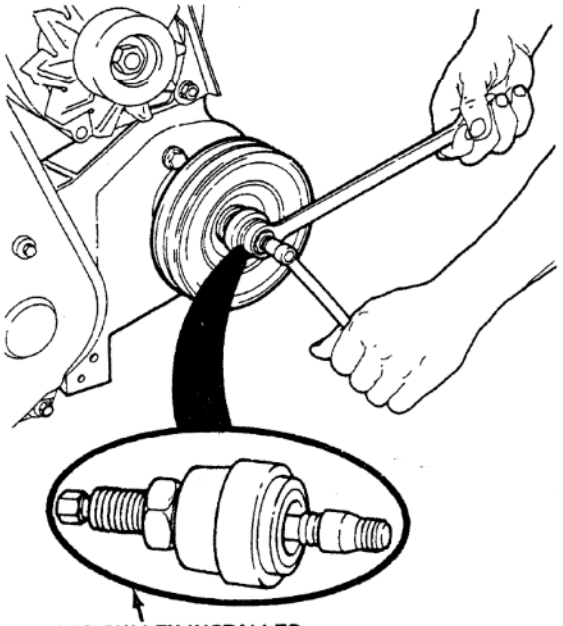
The power steering pump, which is driven by the engine crankshaft through a series of pulleys and belts, develops the hydraulic flow necessary to operate the system. When the steering wheel is turned, the steering gear converts this hydraulic flow into mechanical motion that will move the front wheels in the direction of the turn.

REMOVAL AND INSTALLATION (Continued)

Installation

1. Install the pump pulley using installer T65P-3A733-C, or equivalent.

   Turn the tool nut clockwise to install the pulley. Do not apply in and out pressure on the pump shaft. This movement could damage the pump's internal thrust surfaces.

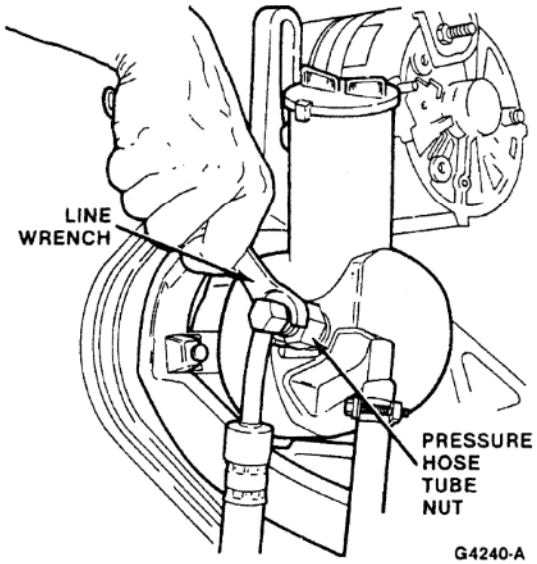


2. Position the drive belts over the pulley and adjust to the specified tension. If necessary, refer to the procedure in this Section.

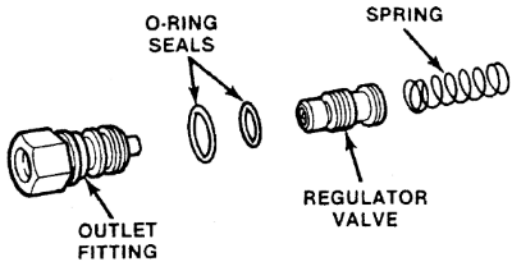
Pressure Regulator Valve

Removal

1. Disconnect the pressure hose at the pump fitting.



2. Remove the outlet fitting, pressure regulator valve and spring.

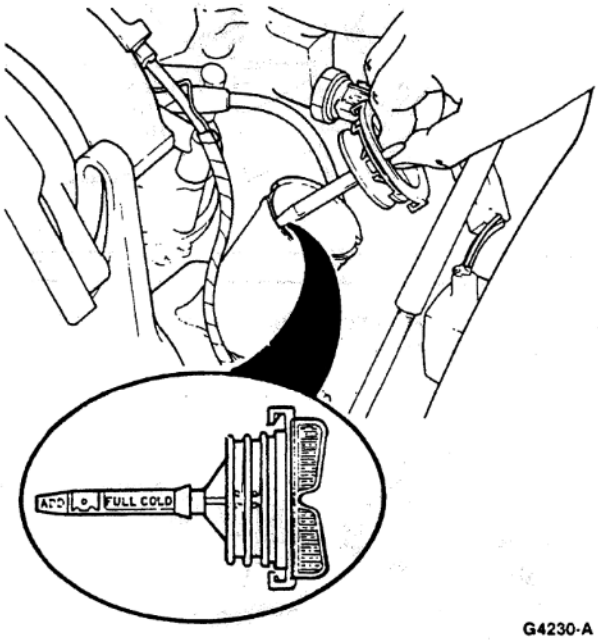


ADJUSTMENTS

Fluid Level

Befor checking the fluid level, let the engine run until it has reached normal operating temperature. With the engine at idle, turn the wheel back and forth several times to get any air out of the steering system. Then turn off the engine and check the fluid level on the dipstick. The level must be between the FULL COLD and FULL HOT mark on the dipstick. Use the proper temperature mark on dipstick when checking fluid level. Do not overfill. Use only a fluid that meets Ford Specifications. Whenever the dipstick is inserted, always make sure it is properly seated and locked in place.

CAUTION: Do not operate the vehicle for prolonged periods with a low power steering pump fluid level to avoid damage to the power steering pump or gear. Use Motorcraft Dexron®II Automatic Transmission Fluid.



G4230-A

Drive Belt Tension

Refer to Section 27-02 for the drive belt tensioning procedure.

REMOVAL AND INSTALLATION

Drive Belts

Refer to Section 27-02 for the drive belt replacement procedure.

Drive Pulley

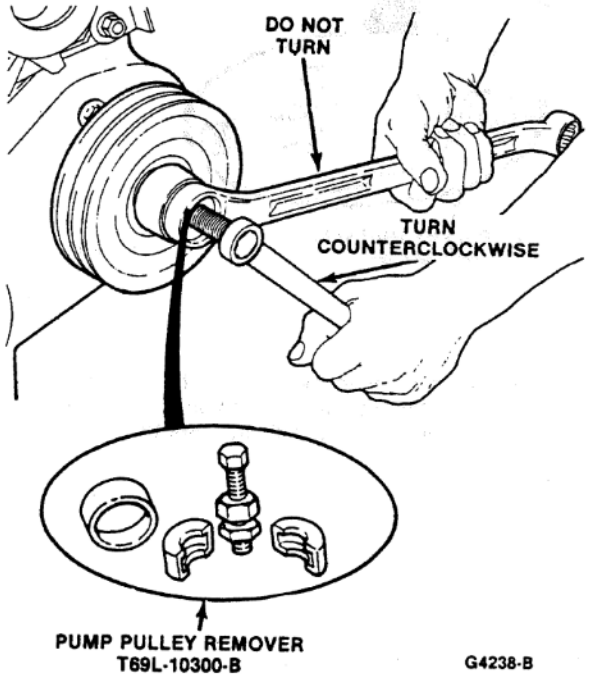
SPECIAL SERVICE TOOLS REQUIRED:

Pump Pulley Remover	T69L-10300-B
Pump Pulley Installer	T65P-3A733-C

Removal

1. Loosen the drive belt adjusting bolts at the alternator and remove the belts from the pulley. If necessary refer to Section 27-02.
2. Remove the pump pulley using Remover T69L-10300-B or equivalent.

   Turn the tool nut counterclockwise to remove the pulley. Do not apply in and out pressure on the pump shaft. This movement could damage the pump's internal thrust surfaces.



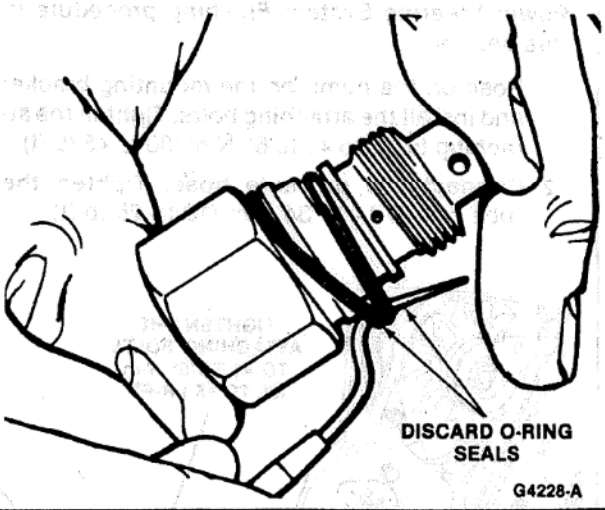
G4238-B

REMOVAL AND INSTALLATION

PRESSURE REGULATOR VALVE

Installation

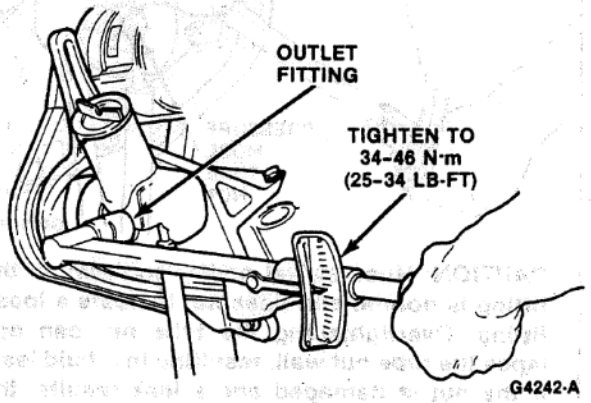
1. Remove the outlet fitting O-rings and install replacement O-rings.



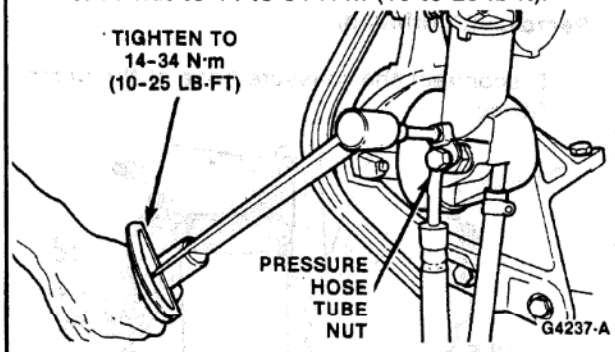
2. Install the spring, pressure regulator valve and outlet fitting.

NOTE: If the valve is cocked, it may become stuck in the valve cover. Do not force the valve forward. Forcing the valve may shear off metal and carry the metal chips into the valve bore.

3. Tighten the outlet fitting to 34 to 46 N·m (25 to 34 lb-ft).



4. Connect the pressure hose. Tighten the tube nut to 14 to 34 N·m (10 to 25 lb-ft).



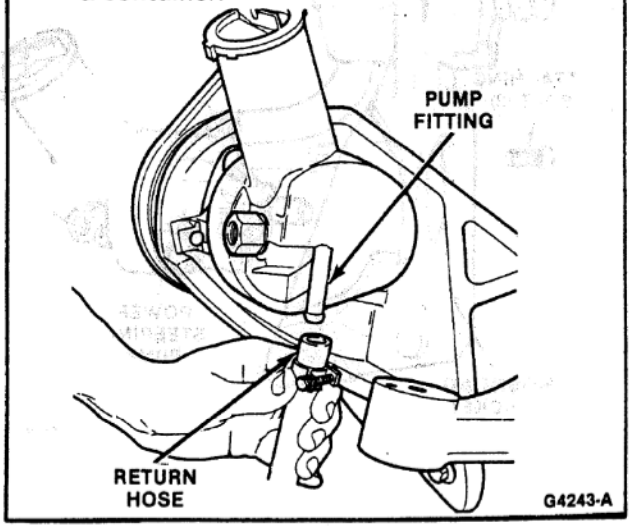
CAUTION: Hose swivel and/or end play in the fitting is normal and does not indicate a loose fitting. Overtightening the tube nut can collapse the tube nut wall, resulting in a fluid leak. If the nut is damaged and a leak results, the pressure hose assembly must be replaced.

5. Fill the reservoir to the correct level using the start-up procedure at the end of this section.
6. After filling, raise the vehicle and check for leaks.

PUMP ASSEMBLY

Removal

1. Remove the pump drive pulley. If necessary, refer to the procedure in this section.
2. Disconnect the fluid return line and allow the fluid in the pump reservoir to drain into a container.

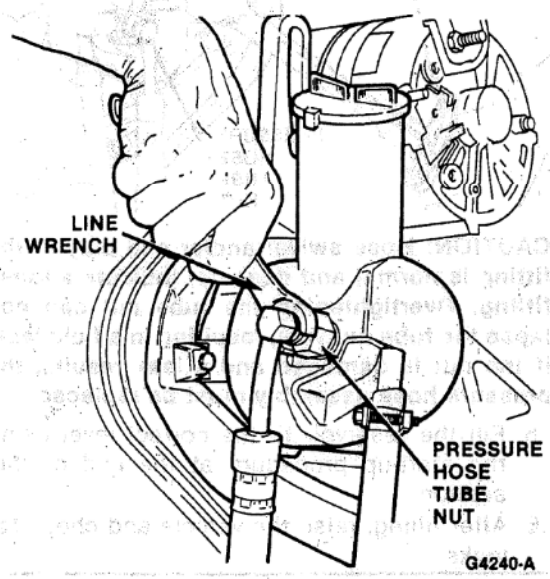


REMOVAL AND INSTALLATION

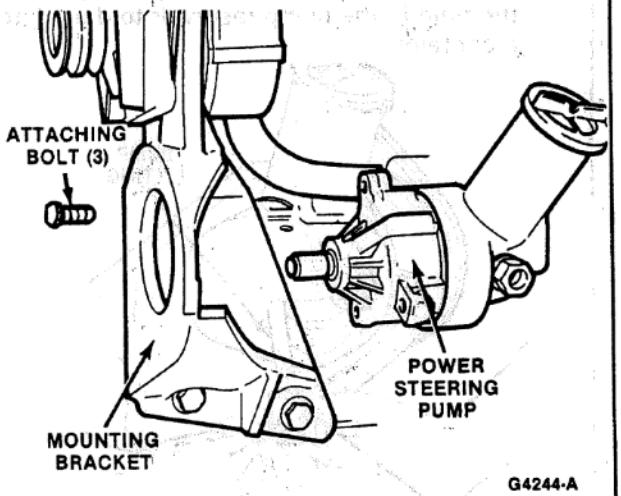
PUMP ASSEMBLY

Removal (Continued)

3. Disconnect the pressure hose at the pump fitting.



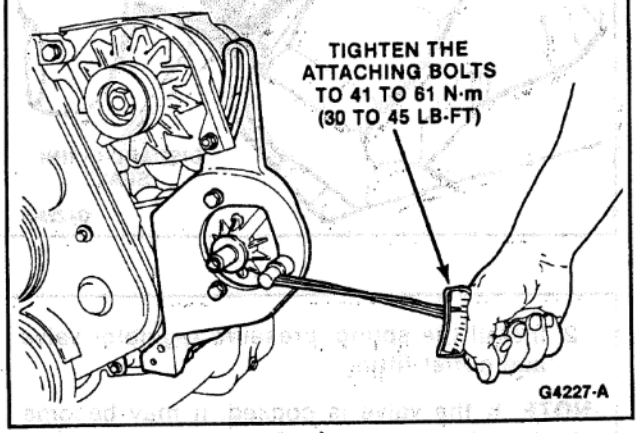
4. Remove the pump attaching bolts and the pump.

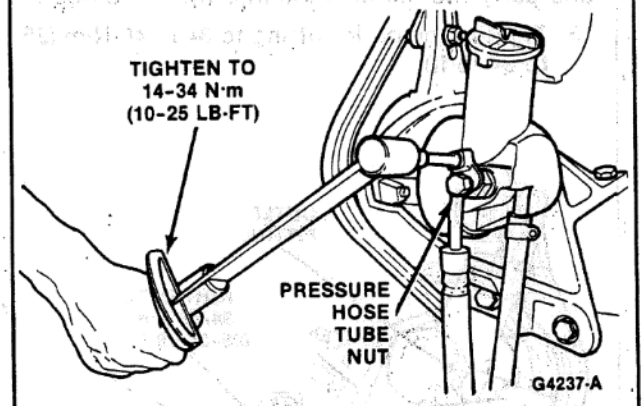


Installation

NOTE: If a new or overhauled pump is being installed, flush the power steering system if contamination of the system was evident during removal of the pump. If necessary, refer to the Power Steering System Flushing procedure in this section.

1. Position the pump on the mounting bracket and install the attaching bolts. Tighten the attaching bolts to 41 to 61 N·m (30 to 45 lb-ft).
2. Connect the pressure hose. Tighten the tube nut to 14 to 34 N·m (10 to 25 lb-ft).





CAUTION: Hose swivel and/or end play in the fitting is normal and does not indicate a loose fitting. Overtightening the tube nut can collapse the tube nut wall, resulting in a fluid leak. If the nut is damaged and a leak results, the pressure hose assembly must be replaced.

REMOVAL AND INSTALLATION

PUMP ASSEMBLY

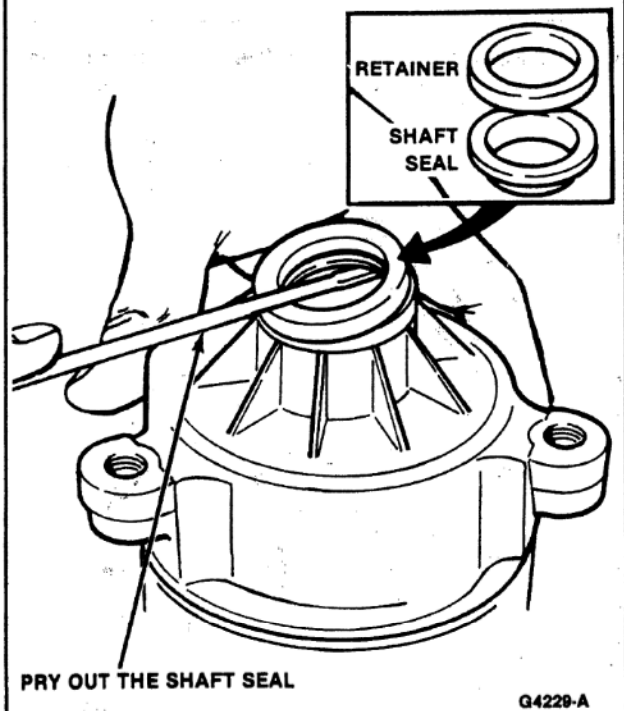
Installation (Continued)

3. Connect the fluid return line.
4. Position the drive belt over the pulley and adjust to the specified tension. If necessary, refer to the procedure in Section 27-02.
5. Fill the reservoir to the correct level using the start-up procedure at the end of this section.
6. After filling, raise the vehicle and check for leaks.

ROTOR SHAFT SEAL

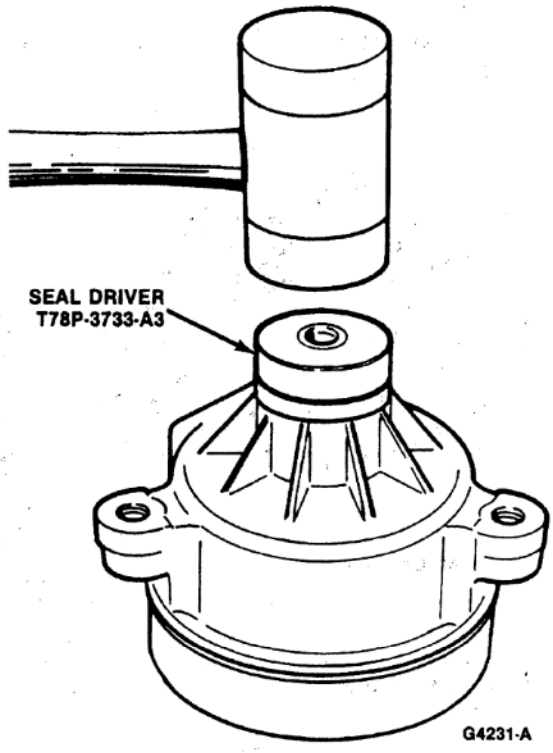
Removal

1. Remove the drive pulley. If necessary, refer to the procedure in this section.
2. Remove the pump from the vehicle. If necessary, refer to the procedure in this section.
3. Using a small screwdriver, pry the shaft seal and retainer out of the pump body. Use care to prevent nicks or scratches on the shaft sealing area.



Installation

1. Install the shaft seal and retainer using Seal Driver T78P-3733-A3, or equivalent.



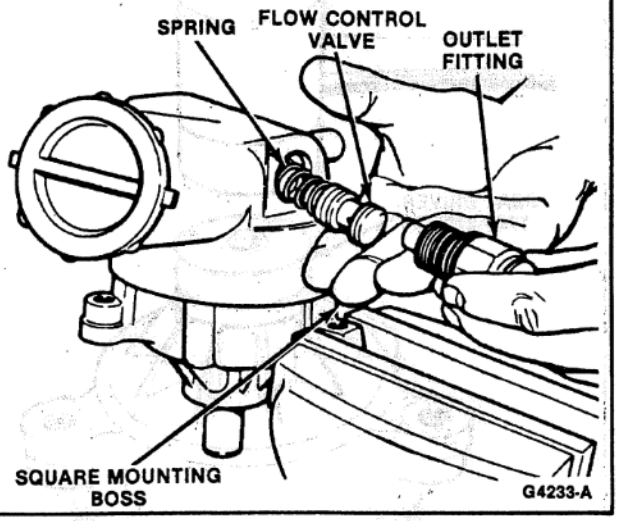
2. Install the pump on the vehicle.
3. Install the drive pulley.

REMOVAL AND INSTALLATION

PUMP RESERVOIR AND O-RING SEAL

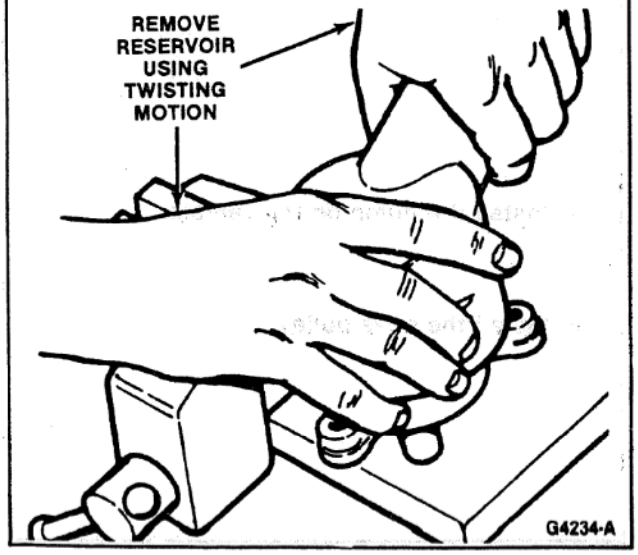
Removal

1. Remove the drive pulley. If necessary, refer to the procedure in this section.
2. Remove the pump from the vehicle. If necessary, refer to the procedure in this section.
3. Clamp the pump in a vise. Tighten the vise on the pump mounting lug only.
4. Remove the outlet fitting, pressure regulator valve and spring.



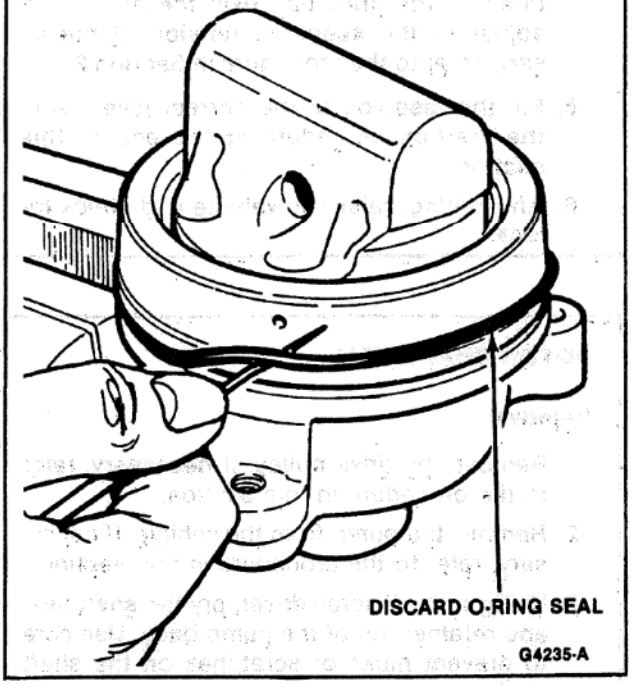
5. Remove the pump reservoir using a twisting motion.

   Do not hammer on the reservoir.

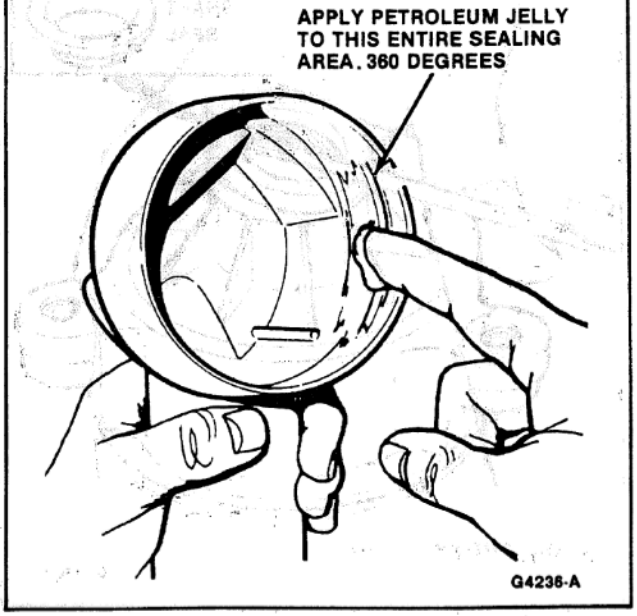


Installation

1. Remove the pump body O-ring and install a replacement O-ring.



2. Lubricate the inside of the reservoir and the pump body O-ring with petroleum jelly.

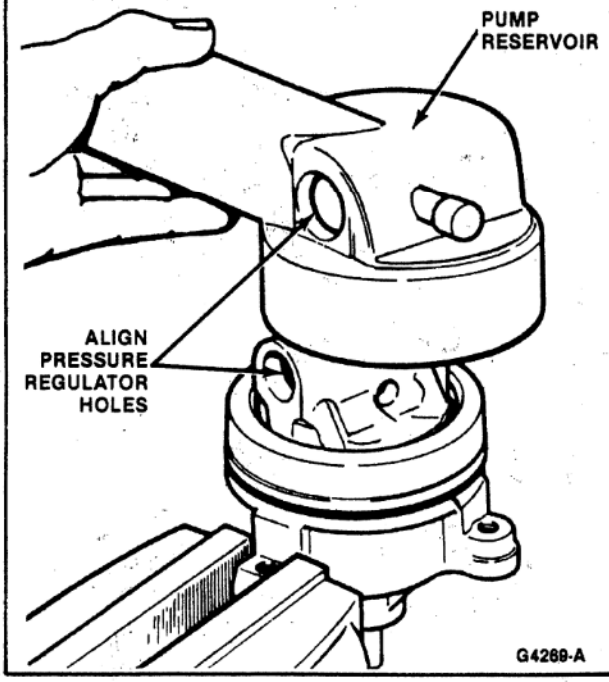


REMOVAL AND INSTALLATION

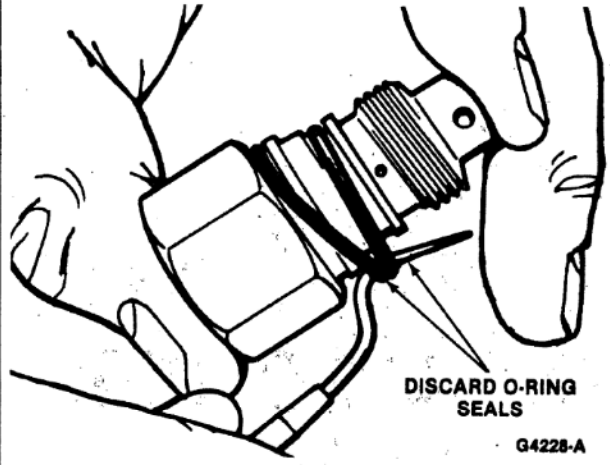
PUMP RESERVOIR AND O-RING SEAL

Installation (Continued)

3. Install the reservoir and align with the pressure regulator bore.



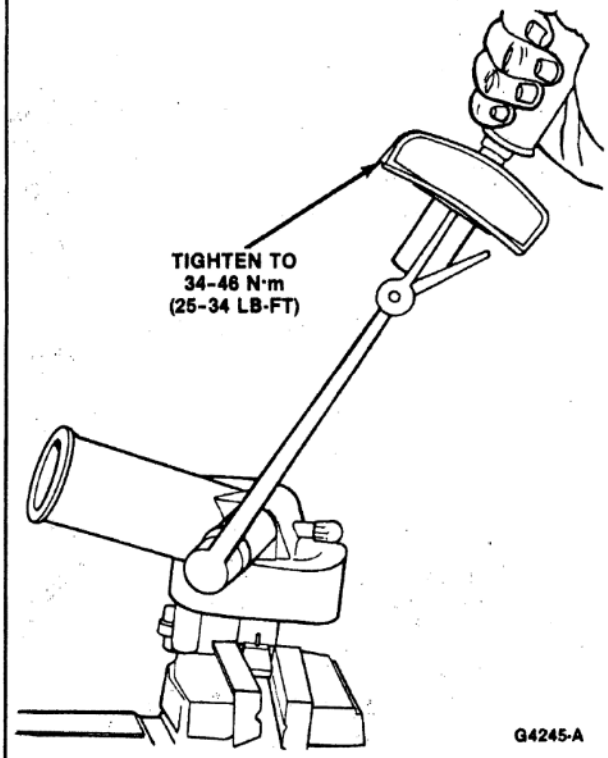
4. Remove the outlet fitting O-rings and install replacement O-rings.



5. Install the spring, pressure regulator valve and outlet fitting.

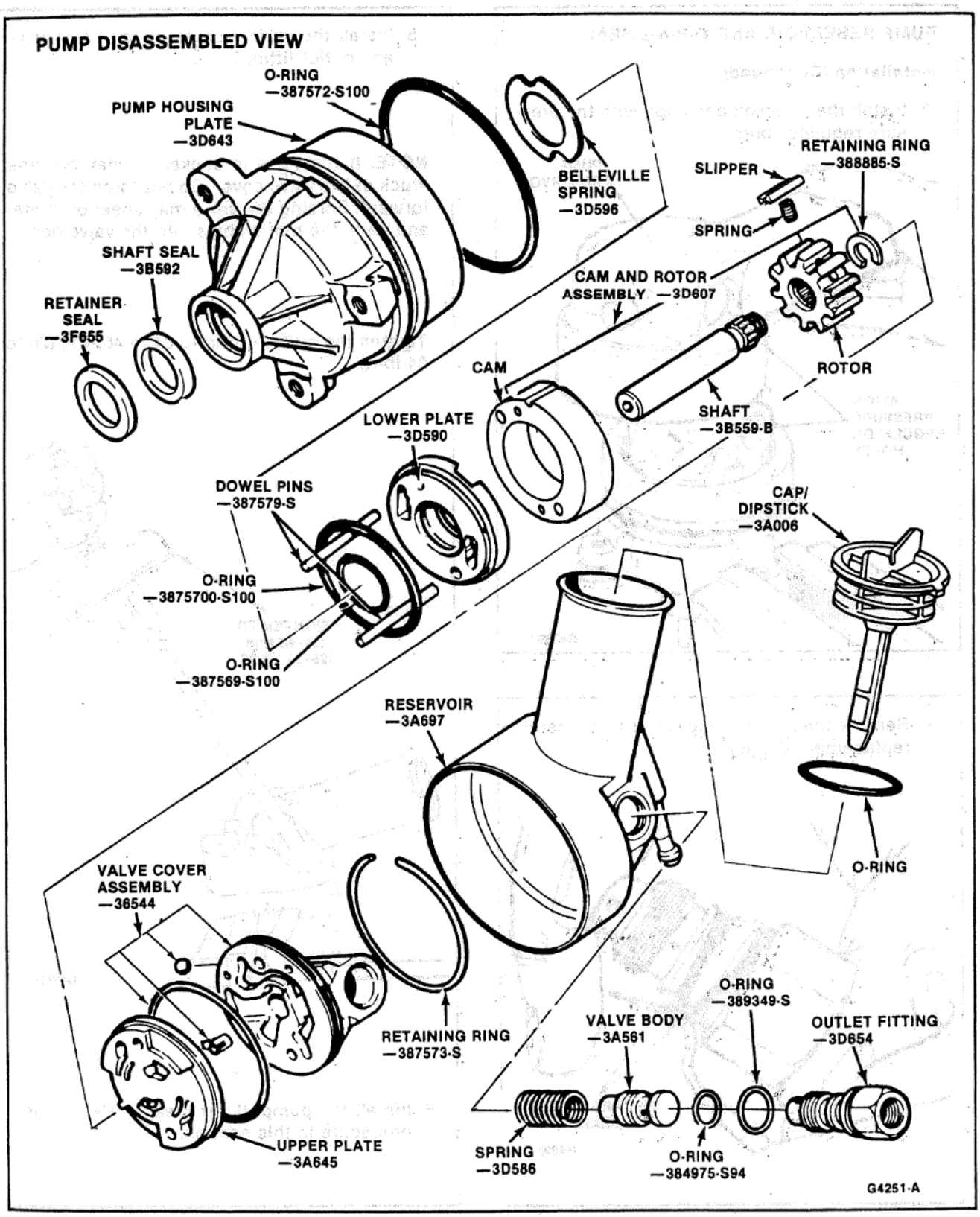
NOTE: If the valve is cocked, it may become stuck in the valve cover. Do not force the valve forward. Forcing the valve may shear off metal and carry the metal chips into the valve bore.

Tighten the outlet fitting to 34 to 46 N·m (25 to 34 lb-ft).



6. Install the pump. If necessary, refer to the procedure in this section.

DISASSEMBLY AND ASSEMBLY



DISASSEMBLY AND ASSEMBLY

PUMP

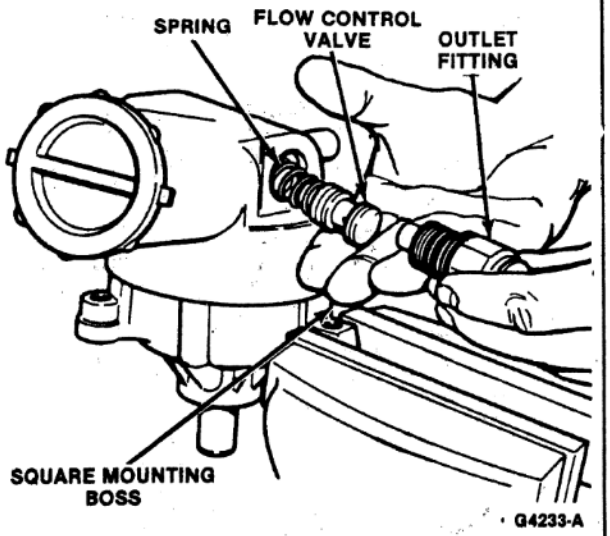
Disassembly

SPECIAL SERVICE TOOLS REQUIRED:

Upper Compressor Plate	T78P-3733-A1
Lower Support Plate	T78P-3733-A2
Seal Driver	T78P-3733-A3
C-Frame and Clamp	T74P-3044-A1

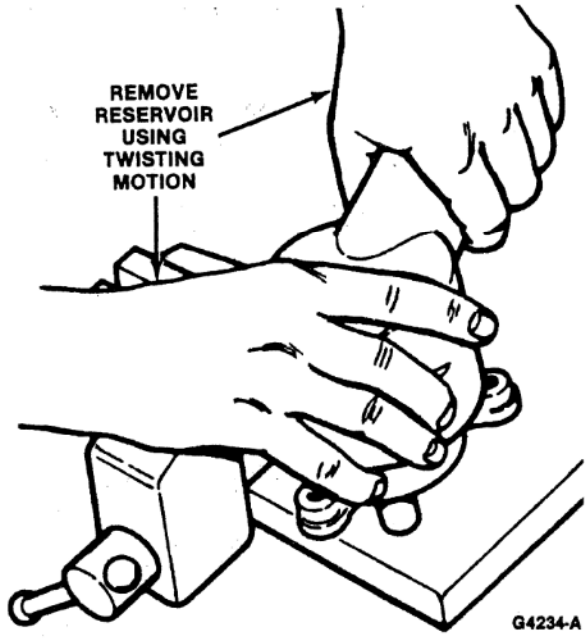
1. Clamp the pump in a vise. Tighten the vise on the pump mounting lug only.

2. Remove the outlet fitting, pressure regulator valve and spring.

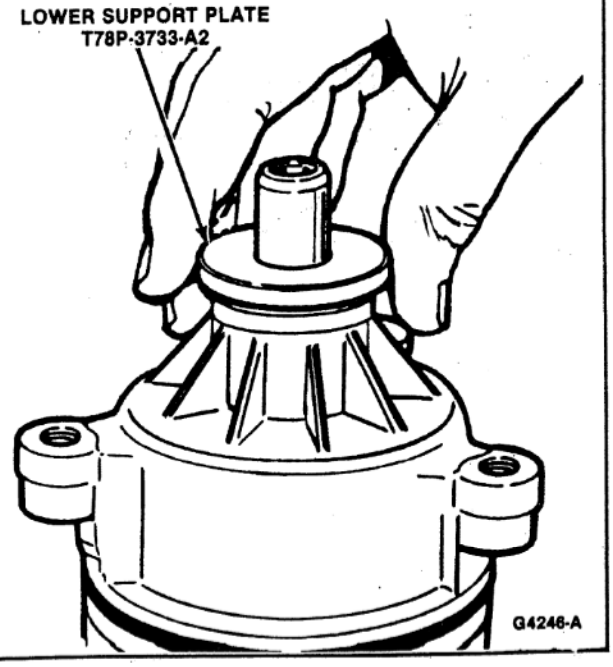


3. Remove the pump reservoir using a twisting motion.

   Do not hammer on the reservoir.



4. Place Lower Support Plate T78P-3733-A2 or equivalent over the pump rotor shaft.



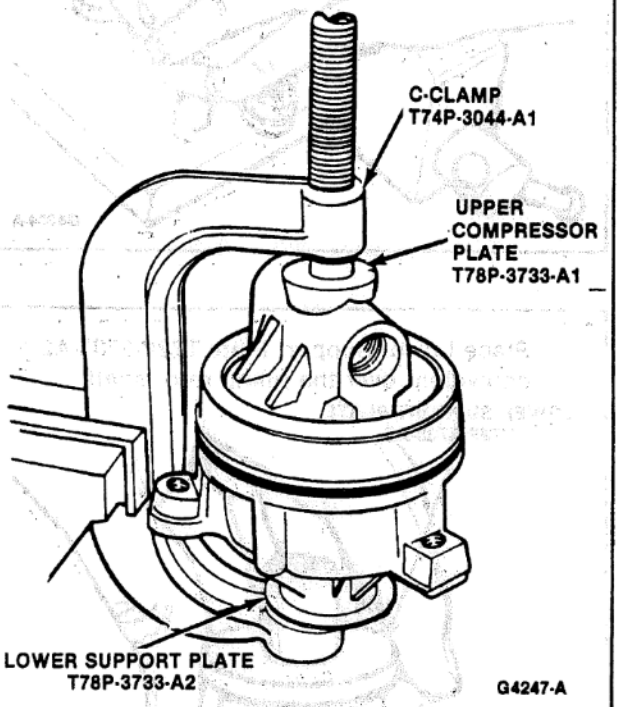
DISASSEMBLY AND ASSEMBLY

PUMP

Disassembly (Continued)

5. Place C-clamp T74P-3044-A1 or equivalent in the vise.

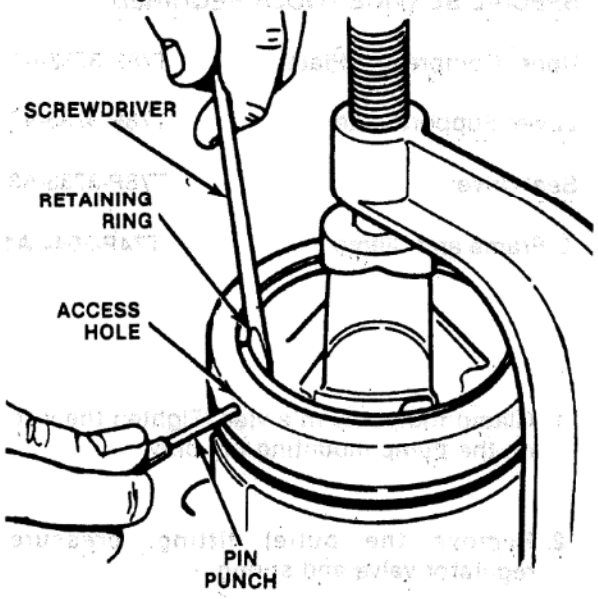
6. While holding the tool on the rotor shaft, turn the pump body over and position it in the C-clamp with Upper Compressor Plate T78P-3733-A1, or equivalent.



7. Tighten the C-clamp until a slight bottoming is felt.

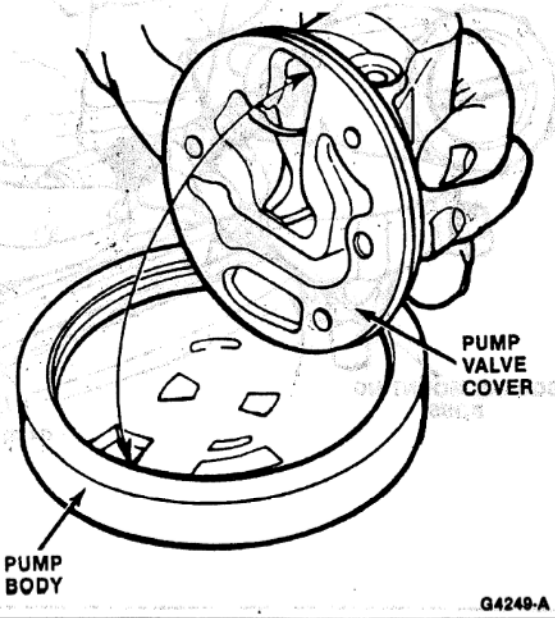
8. Insert a pin punch through the access hole and push inward on the retaining ring.

   Using a screwdriver, pry the ring out of the housing.



9. Remove the pump body from the C-clamp and the support plate from the rotor shaft.

10. Remove the pump valve cover.

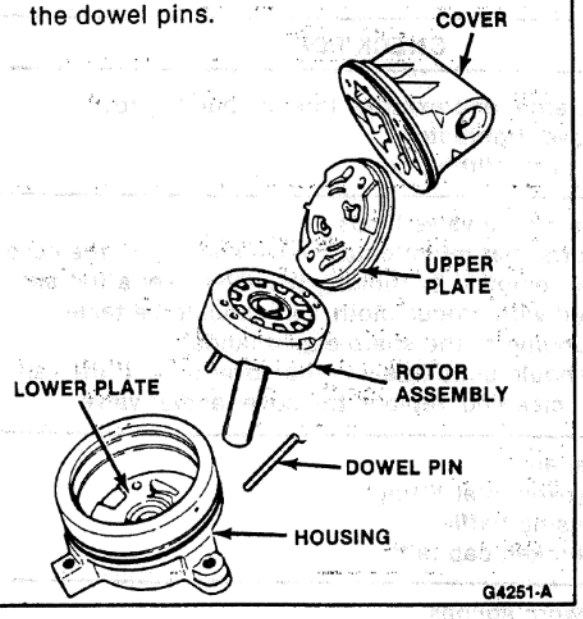


DISASSEMBLY AND ASSEMBLY

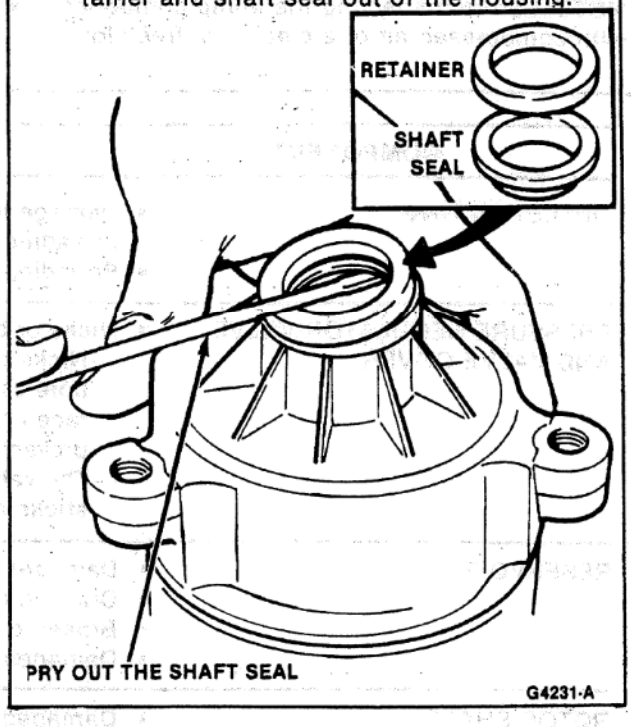
PUMP

Disassembly (Continued)

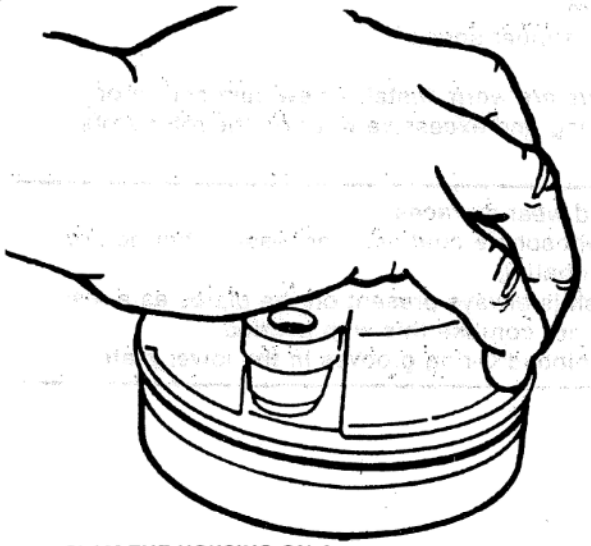
11. Push the rotor shaft through the housing to remove the upper plate, rotating group and the dowel pins.



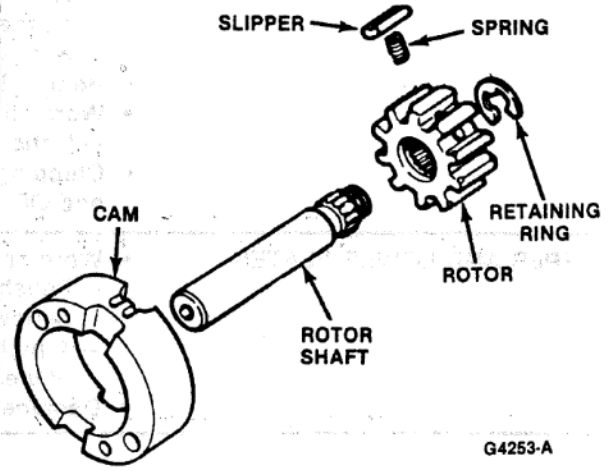
13. Using a screwdriver, carefully pry the retainer and shaft seal out of the housing.



12. To remove the lower plate and belleville washer, tap the housing on a flat wooden surface until the components fall out of the housing.



14. Slide the rotor out of cam and remove the springs and pump slippers.



15. Remove the retaining ring and slide the shaft out of the rotor.
16. Refer to the Power Steering Pump Component Inspection Chart for cleaning instructions and inspection points.

POWER STEERING PUMP

COMPONENT INSPECTION CHART

NOTE: Before inspecting the pump components, wash them thoroughly in cleaning solvent and dry them with compressed air or a clean, lint-free cloth.

COMPONENT	CHECK FOR:
OUTLET FITTING	• Damage to internal and external threads due to cross-threading or over tightening • Rounding off of the fitting hex
PRESSURE REGULATOR VALVE AND VALVE COVER	• Nicks or burrs on the valve lands —Nicks or burrs that might cause valve sticking in the cover bore can be removed by rubbing the valve over a flat surface covered with crocus cloth. Care should be taken to prevent rounding of the sharp-edged lands. —The valve should slide freely in the cover bore. If the valve sticks after cleaning, replace the cover and/or valve.
RESERVOIR	• Damaged seal area • Cracked or broken inlet fitting • Broken or missing baffle • Damaged or broken cap tabs
ROTOR SHAFT	• Damaged or worn splines • Damaged or worn clip groove • Worn or scored thrust faces, bushing area and seal area
ROTATING GROUP	• Wear on the cam —Wear must be limited to removal of the phosphate coating on the cam contour. Replace the cam if it is excessively worn or scored. • Bent or broken slipper springs • Worn slippers —If the slippers are worn, install a new cam and rotor. • Chipping, scoring and excessive wear on the rotor slots and OD
UPPER AND LOWER PLATES	• Worn or scored wear surfaces —Polish the phosphate coating, if necessary, but do not remove the coating. —A high polish is always present on the plates as a result of wear. Do not confuse this with scoring. • Damaged or chipped O-ring grooves in the lower plate

CG4254-A

POWER STEERING PUMP
COMPONENT INSPECTION CHART (Continued)

COMPONENT	CHECK FOR:
PUMP HOUSING	• Damaged or stripped threaded holes — Repair threaded holes by drilling out the damaged threads and installing helicoil inserts. • Worn or scored shaft bushing — The bushing is serviceable if it is not worn 0.01mm (.0005 in.) over the 18mm (.6897 in.) maximum ID. If the bushing is worn or scored, replace the pump housing. • Chipped or otherwise damaged retaining ring groove • Cracks in the casting
VALVE COVER	• Nicks or burrs in the valve bore — Nicks or burrs can be removed with crocus cloth. — The valve should slide freely in the cover bore. • Chipped or otherwise damaged O-ring seal groove • Loose or missing bore plug

CG4255-A

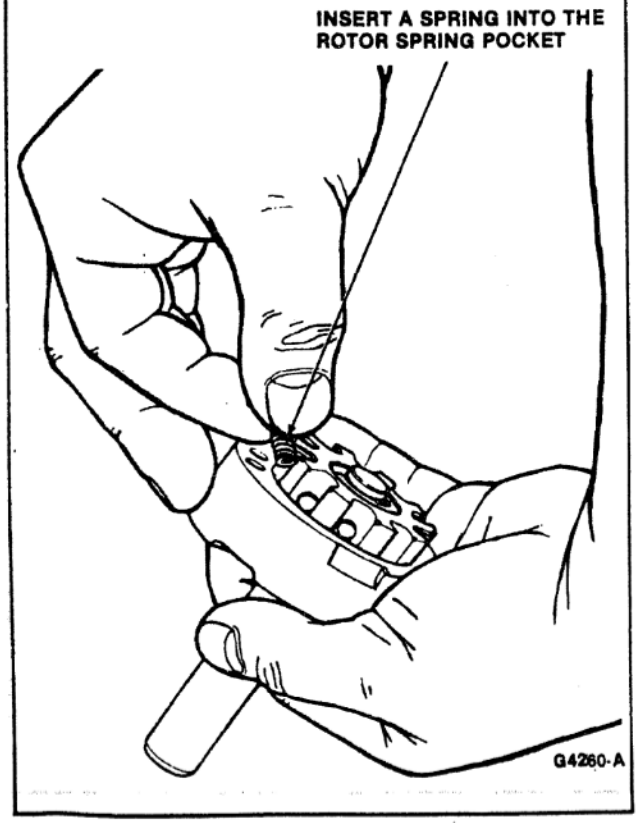
DISASSEMBLY AND ASSEMBLY

PUMP

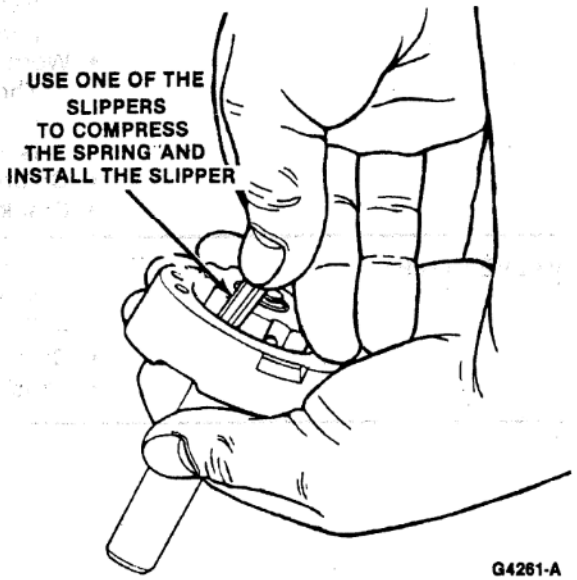
Assembly

Do not allow dirt to enter the pump during assembly. All parts must be clean and lubricated with power steering fluid. Never re-use the O-ring seals. Always install new seals.

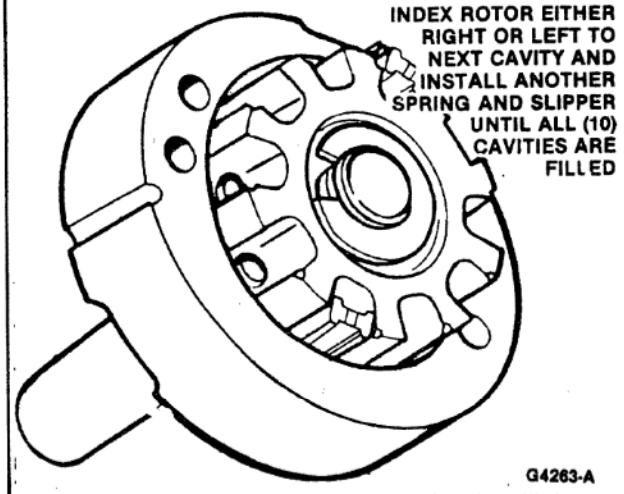
1. Install the rotor on the shaft and install the retaining ring. Make sure the large counterbore on the rotor faces the retaining ring.
2. Place the cam over the rotor with the recessed notch facing up.
3. Extend the rotor about halfway out of the cam.
4. Rotate the cam to align a rotor slot with the recess in the cam and install a slipper spring.



5. Use the slipper to compress the spring and slide the slipper into the rotor slot with the groove facing up.



6. Install another spring and slipper in the rotor slot aligned with the recess on the opposite side of the cam.
7. While holding the cam, turn the rotor either left or right to align the next rotor slot with the cam recess.



DISASSEMBLY AND ASSEMBLY

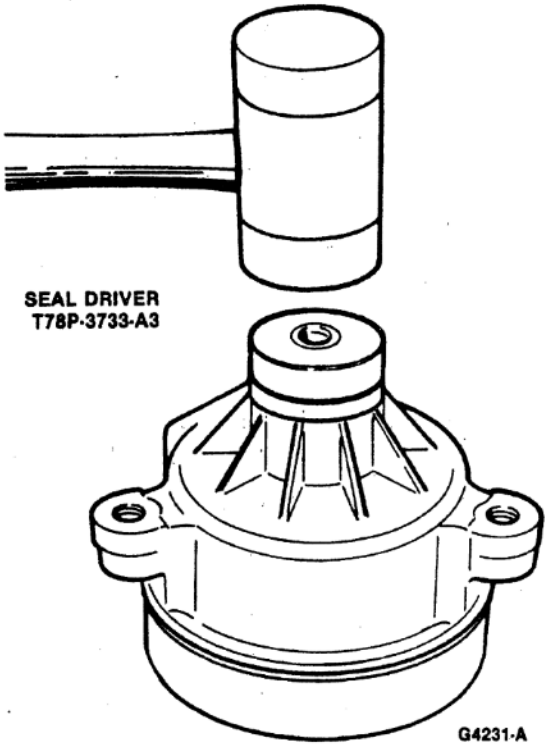
PUMP

Assembly (Continued)

8. Install the remaining eight springs and slippers. If care is used, the springs and slippers will not fall out as the rotor is turned to the next alignment position.

9. Install the rotor shaft seal using Seal Driver T78P-3733-A3, or equivalent.

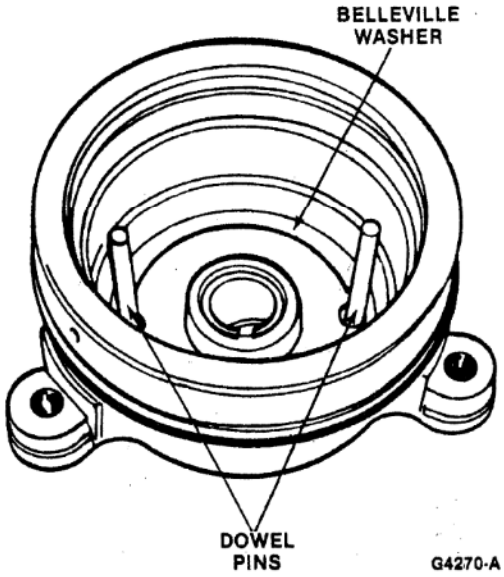
   Drive the seal into the bore until the tool bottoms against the housing.



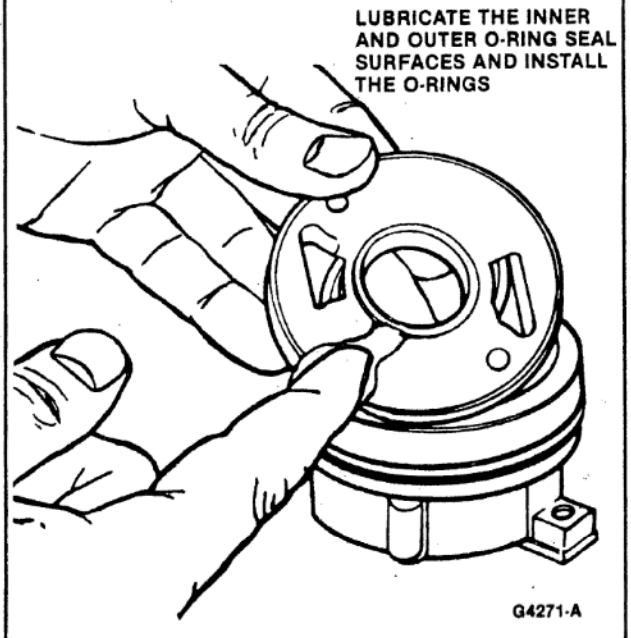
10. Install the seal retainer using Seal Driver T78P-3733-A3, or equivalent.

11. Install the belleville washer and dowel pins in the housing.

    Make sure the dished side of the washer faces upward.



12. Lubricate and install the lower plate O-rings.

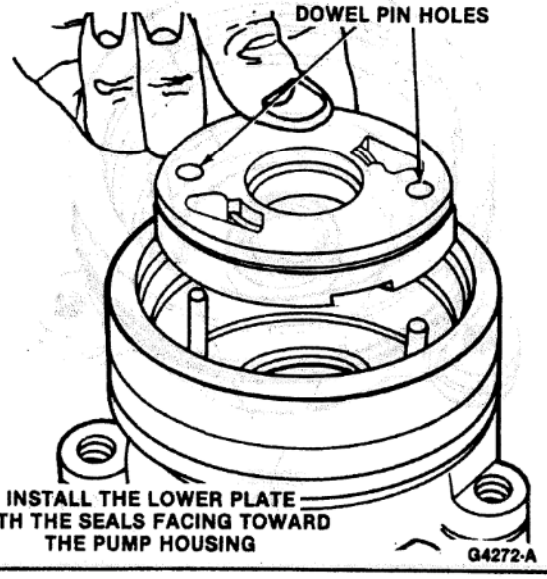


DISASSEMBLY AND ASSEMBLY

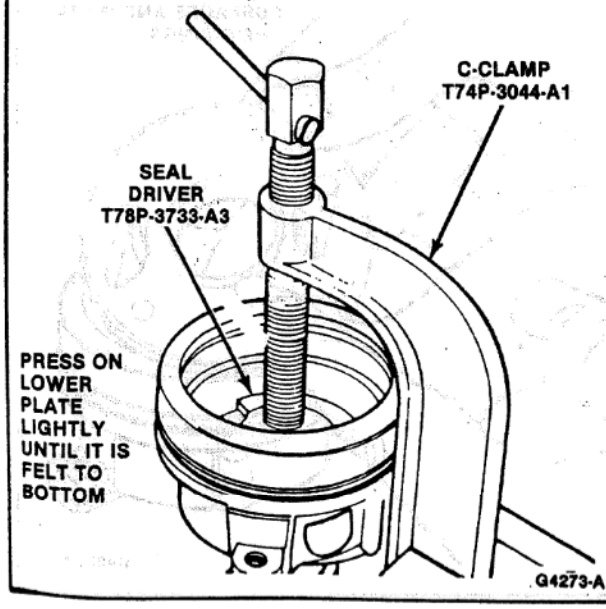
PUMP

Assembly (Continued)

13. Position the lower plate over the dowels in the pump housing with the O-rings facing the front of the housing.

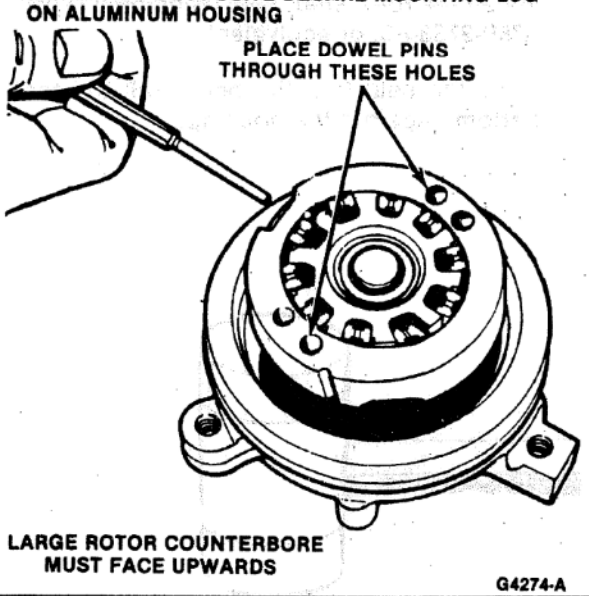


14. Using C-clamp T74P-3044-A1 and Seal Driver T78P-3733-A3, or equivalent, lightly press the lower plate into the housing until it bottoms. Remove C-clamp and installer.



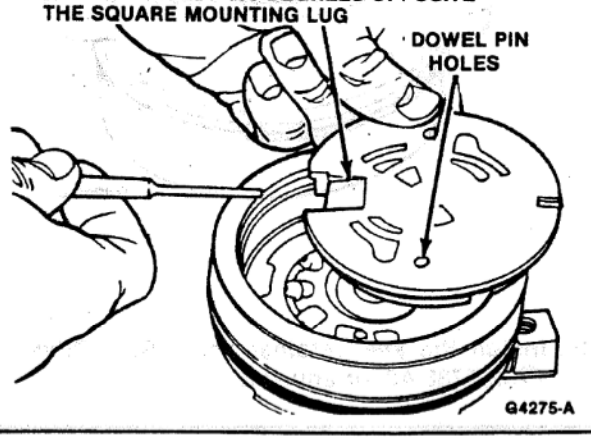
15. Install the rotating group in the pump housing.

When installing the rotating group, the stepped holes in the cam must be positioned over the dowel pins. The notch on the outside edge of the cam must face the reservoir. The reservoir is approximately 180 degrees away from the square mounting lug.



16. Install the upper plate over the dowel pins.

Make sure the recess in the plate aligns with the notch on the outside edge of the cam.

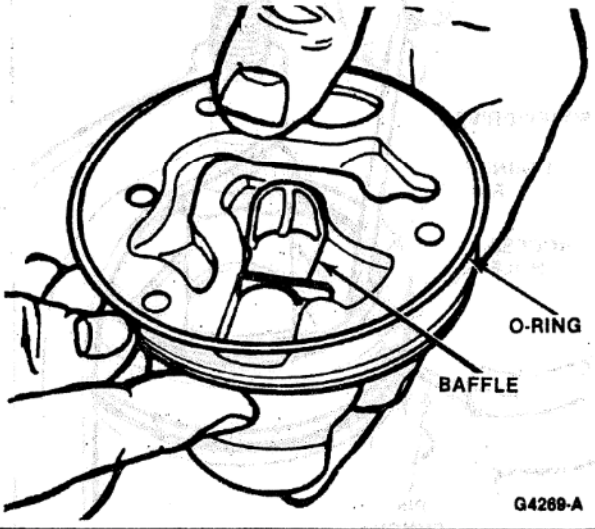


DISASSEMBLY AND ASSEMBLY

PUMP

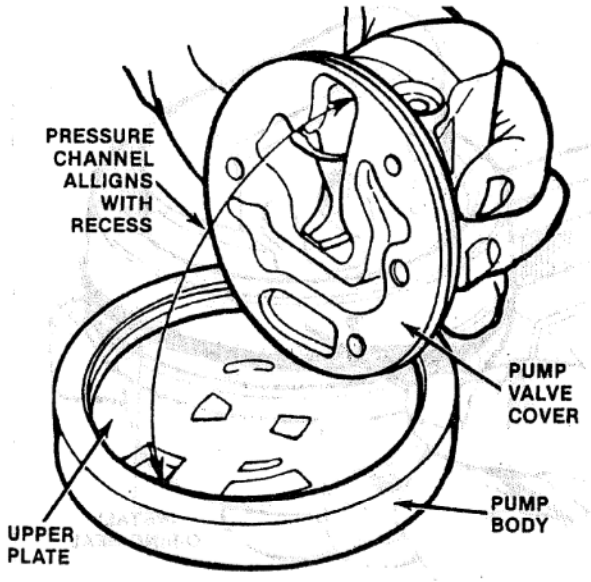
Assembly (Continued)

17. Lubricate and install the pump valve cover O-ring.



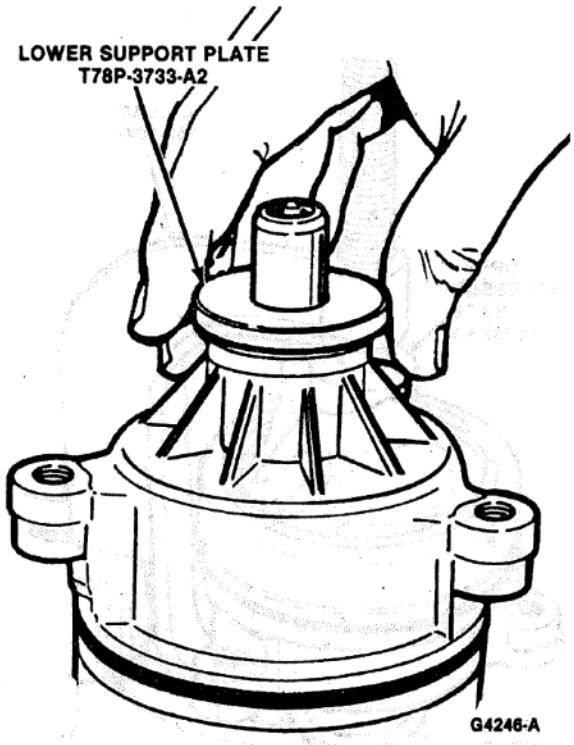
18. Install the pump valve cover over the dowel pins.

    Make sure the pressure channel in the cover is positioned directly over the recess in the upper plate.



NOTE: Be sure that the plastic baffle is placed securely in the valve cover. If the baffle is loose, apply a coating of petroleum jelly on the baffle, and install it on the valve cover.

19. Place Lower Support Plate T78P-3733-A2, or equivalent, over the pump rotor shaft.



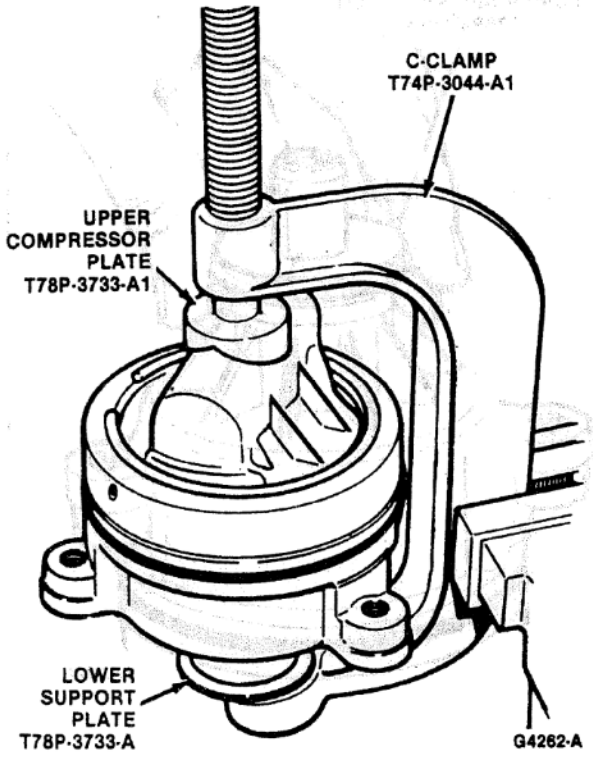
DISASSEMBLY AND ASSEMBLY

PUMP

Assembly (Continued)

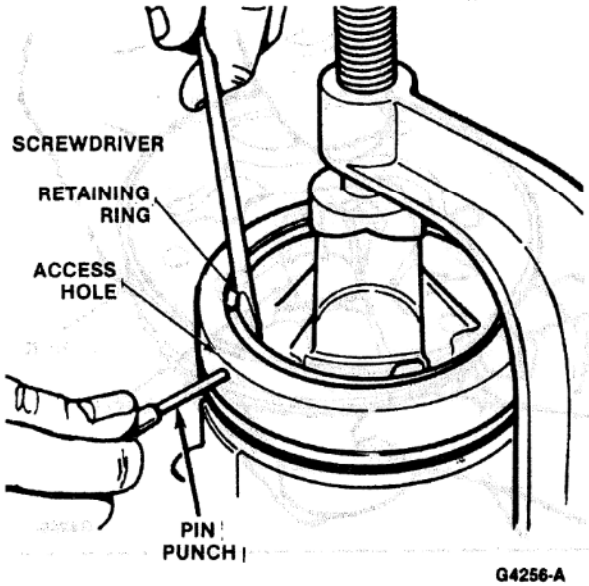
20. Place C-clamp T74P-3044-A1 in the vise.

21. While holding the tool on the rotor shaft, turn the pump body over and position it in the C-clamp with Upper Compressor Plate T78P-3733-A1, or equivalent.



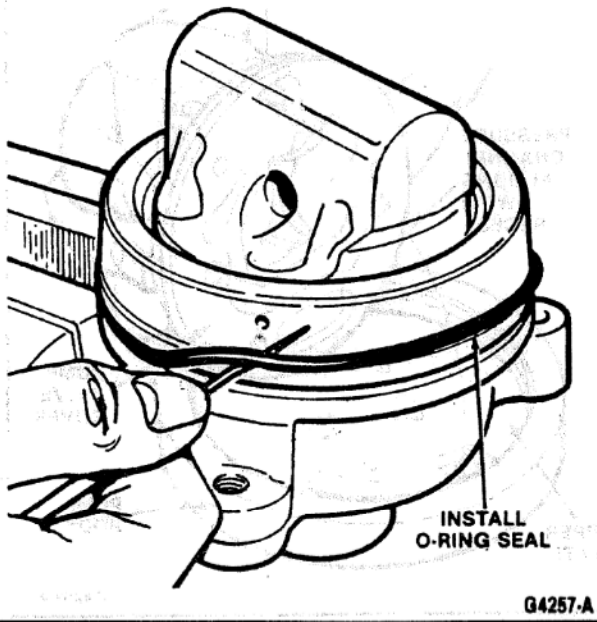
22. Tighten the C-clamp until a slight bottoming is felt.

23. Install the valve cover retaining ring with the ends near the access hole in the pump housing.



24. Remove the pump assembly from the C-clamp.

25. Install the pump body O-ring.

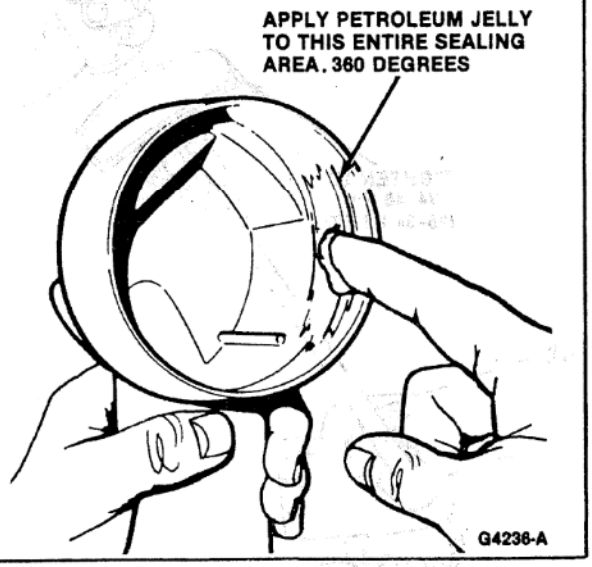


DISASSEMBLY AND ASSEMBLY

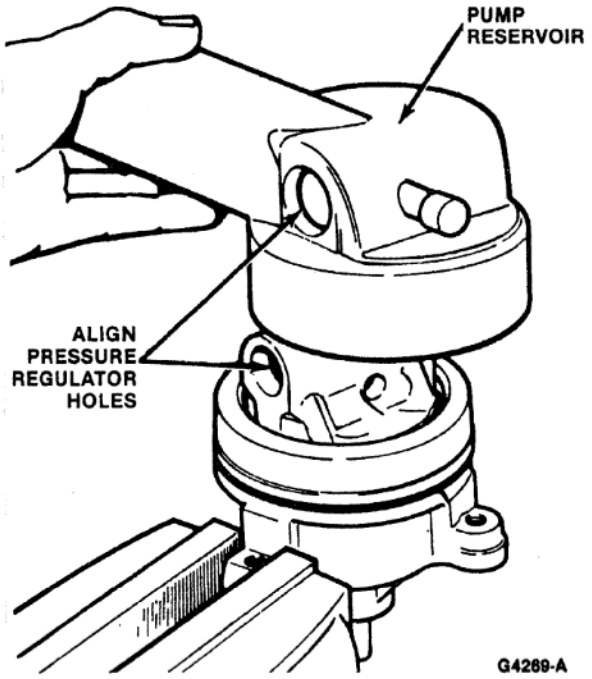
PUMP

Assembly (Continued)

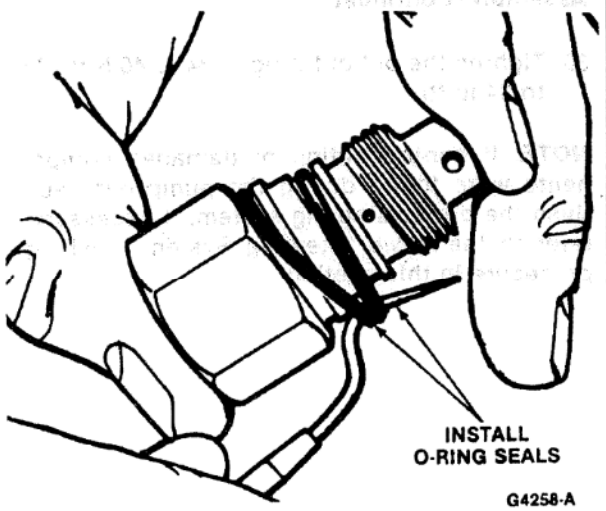
26. Lubricate the inside of the reservoir and the pump body O-ring with petroleum jelly.



27. Install the reservoir and align with the pressure regulator bore.

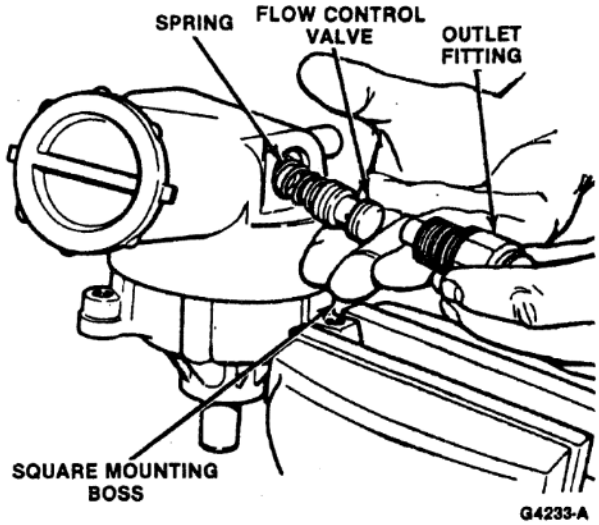


28. Lubricate and install the outlet fitting O-rings.



29. Install the spring, pressure regulator valve and outlet fitting.

NOTE: If the valve is cocked, it may become stuck in the valve cover. Do not force the valve forward. Forcing the valve may shear off metal and carry the metal chips into the valve bore.



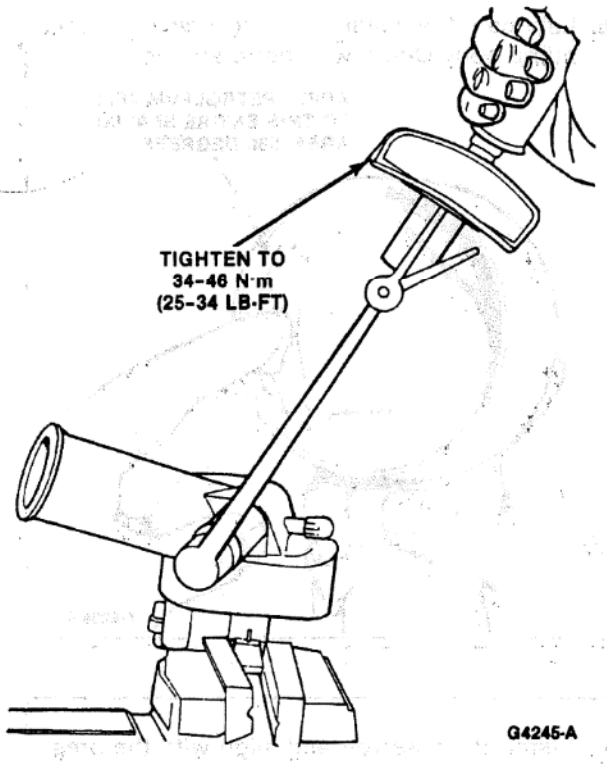
DISASSEMBLY AND ASSEMBLY

PUMP

Assembly (Continued)

30. Tighten the outlet fitting to 34 to 46 N·m (25 to 34 lb-ft).

NOTE: If contamination or damaged components were found during the pump overhaul, flush the power steering system. If necessary, refer to the Power Steering System Flushing procedure in this section.



GENERAL SERVICE PROCEDURES

Start Up Procedure

After Power Steering Pump or Gear Overhaul

After engine start up, follow these steps to eliminate excessive steering system noise due to air trapped in the system during service:

1. Disconnect the coil wire.
2. Fill the pump reservoir to the specified level.
3. Crank the engine with the starter. Add fluid until the level remains constant.
4. While cranking the engine, rotate the steering wheel from stop to stop. **Front wheels must be off the floor during stop-to-stop rotation of the steering wheel.** Recheck the fluid level. Add fluid if necessary.
5. Reconnect the coil wire.
6. Start the engine and allow it to run for several minutes.
7. Rotate the steering wheel from far left to far right.
8. Turn off the engine and recheck the fluid level. Add fluid if necessary.
9. If air is still present, refer to the Purging Power Steering System of Air procedure in Section 13-01.

Power Steering System Flushing

If the power steering pump has been replaced or overhauled, it is good practice to flush the power steering gear and lines before the pump is put into service. To remove possible contamination from the gear and lines, perform the following procedure:

1. Remove and flush the power steering pressure hose.

   After flushing, install the hose.
2. Place the fluid return line from the gear in a container, and plug the reservoir return line fitting at the reservoir.
3. Fill the reservoir with Motorcraft Dexron®II Automatic Transmission Fluid.
4. Disconnect the coil wire, and raise the front wheels off the ground.
5. Add approximately 2 liters (2 quarts) of fluid while cranking the engine with the starter and turning the steering wheel from left to right.
6. When all the fluid has been added, stop cranking the engine.
7. Remove the plug from the reservoir return fitting and attach the line to the reservoir.
8. Fill the pump reservoir to the specified level.
9. Crank the engine with the starter, and add fluid until the level remains constant.
10. While cranking the engine, rotate the steering wheel from stop to stop. Front wheels must be off the floor during stop-to-stop rotation of the steering wheel. Recheck the fluid level, and add fluid if necessary.
11. Reconnect the coil wire.
12. Start the engine, and allow it to run for several minutes.
13. Rotate the steering wheel from far left to far right.
14. Turn off the engine and recheck the fluid level. Add fluid if necessary.
15. If air is still present, refer to the Purging Power Steering System of Air procedure in Section 13-01.

SECTION 13-55 POWER STEERING HOSES

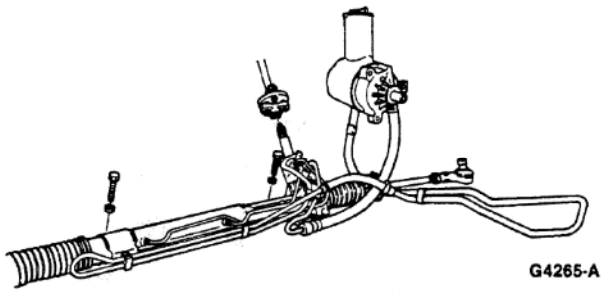
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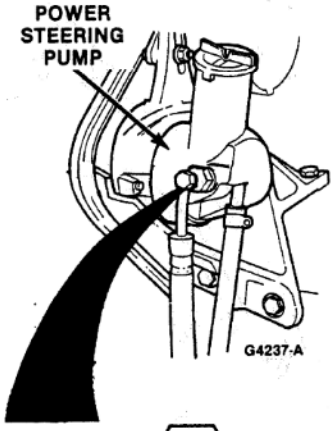
REMOVAL AND INSTALLATION

Pressure Hose 3
Return Hose 4
Primary Cooler 5
Secondary Cooler 6
Seal Replacement and Inspection 6

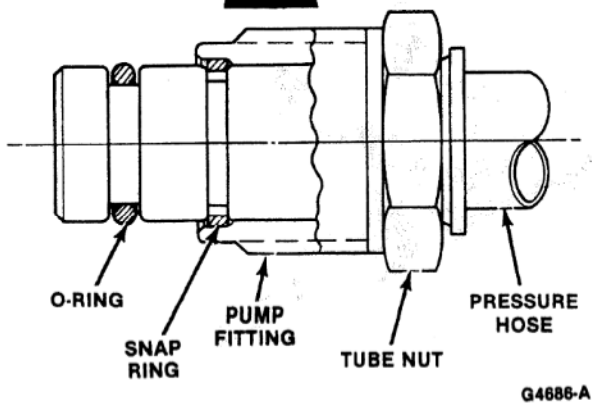

G4265-A

DESCRIPTION

The power steering system is equipped with two hoses: a pressure hose and a return hose. A primary cooler and a secondary cooler complete the system's return line. The pressure hose is connected to the pump with a quick-connect fitting, including a snap ring and an O-ring seal.

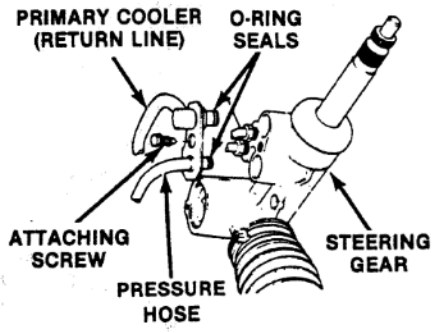


G4237-A



G4686-A

Fluid flows from the pump to the steering gear through the pressure hose. The fluid returns to the pump from the gear through first the primary cooler, then the secondary cooler, then the return hose.



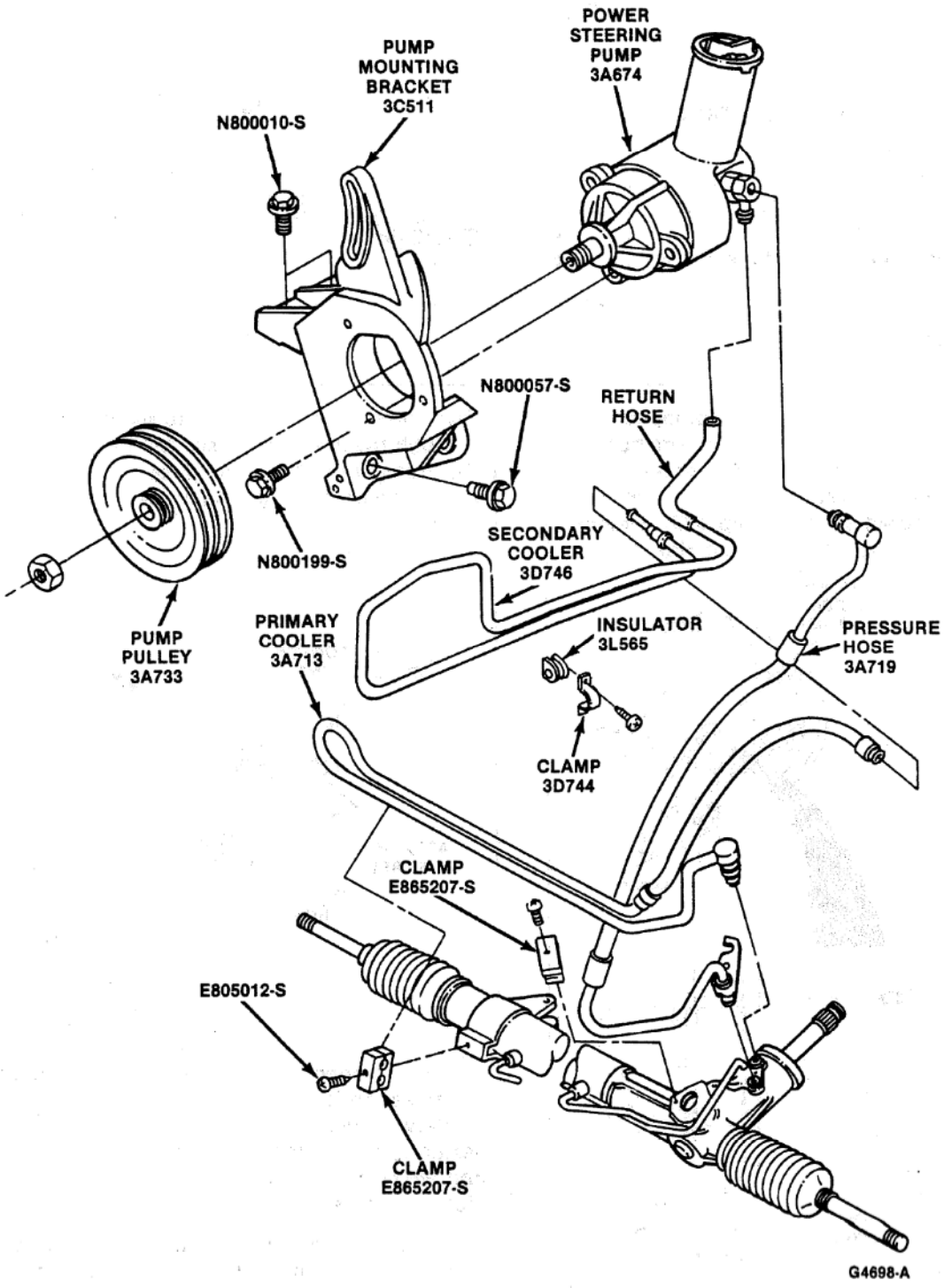
G4687-A

The return hose is connected to the pump and to the secondary cooler with hose clamps. The primary cooler and the pressure hose are inserted into the steering gear with O-ring seals and are held in position with a single mounting plate and screw.

The primary cooler is connected to the secondary cooler by a short hose with hose clamps.

DESCRIPTION

POWER STEERING HOSES DISASSEMBLED VIEW

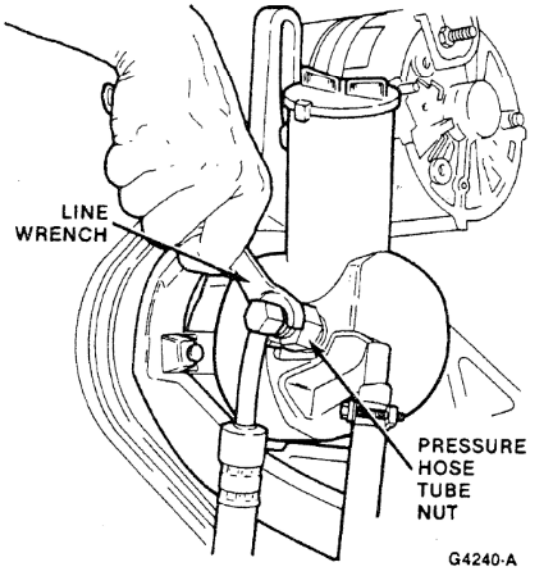


REMOVAL AND INSTALLATION

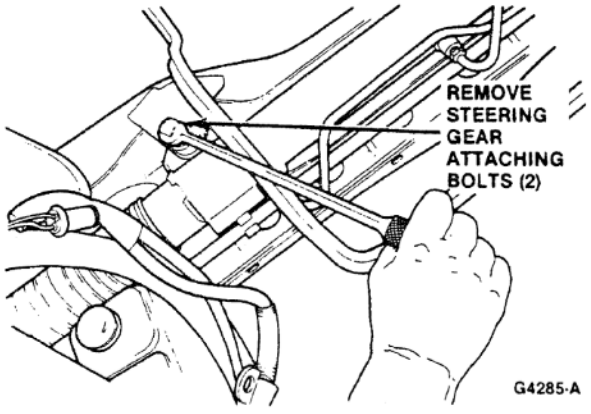
Pressure Hose

Removal

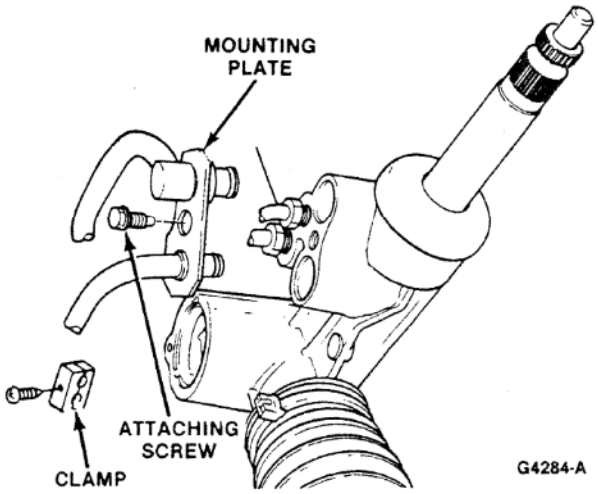
1. Place suitable containers below the pressure hose fittings at the power steering pump and gear.
2. Disconnect the pressure hose at the pump fitting. Plug the pump fitting to prevent entry of contaminants.



3. Raise the vehicle, and remove the steering gear attaching bolts. Pull the steering gear away from the crossmember. Support the gear with wire attached to a convenient underbody component.



4. Remove the routing clamp attaching the pressure hose and primary cooler to the steering gear.



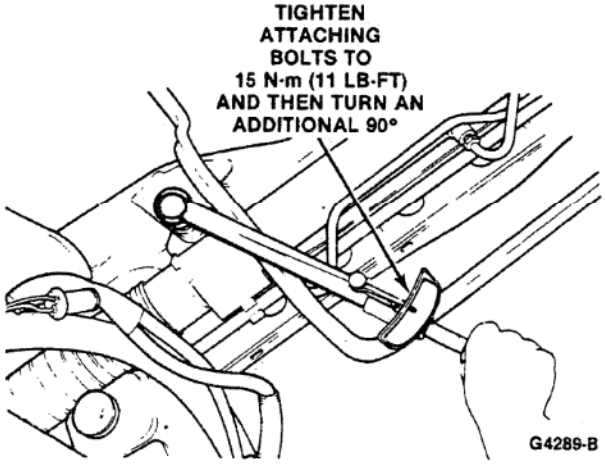
5. Disconnect the pressure hose from the steering gear by removing the washer-head screw securing the mounting plate to the steering gear. Rotate the mounting plate away from the primary cooler fitting and pull the pressure hose fitting out of the steering gear port. Plug the housing port to prevent the entry of contaminants.

Installation

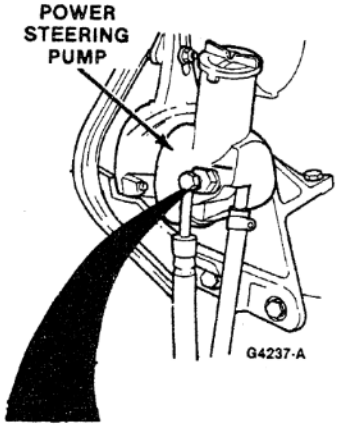
1. Position the pressure hose in the steering gear and rotate the mounting clamp into position on the primary cooler fitting.
2. Install the mounting plate attaching screw.
3. Install the routing clamp.

REMOVAL AND INSTALLATION (Continued)

4. Position the steering gear on the crossmember.
5. Install new steering gear attaching bolts and tighten until snug (about 15 N·m or 11 lb-ft). Then turn the bolts an additional 90°.



6. Connect the pressure hose to the pump fitting. Tighten the tube nut to 14 to 34 N·m (10 to 25 lb-ft).



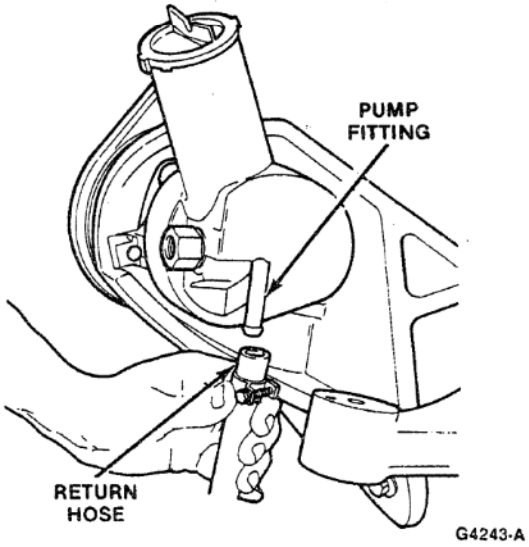
CAUTION: Hose swivel and/or endplay in the fitting is normal and does not indicate a loose fitting. Overtightening the tube nut can collapse the tube nut wall, resulting in a fluid leak. If the nut is damaged and a leak results, the pressure hose assembly must be replaced.

7. Refill the power steering system. If necessary refer to Section 13-51.

Return Hose

Removal

1. Place suitable containers beneath the power steering pump and the return hose connection at the secondary cooler.
2. Loosen the clamp and disconnect the return hose from the pump fitting. Plug the fitting if you do not wish to drain the pump.



3. Raise the vehicle.
4. Loosen the clamp and disconnect the return hose from the secondary cooler.
5. Remove the hose.

Installation

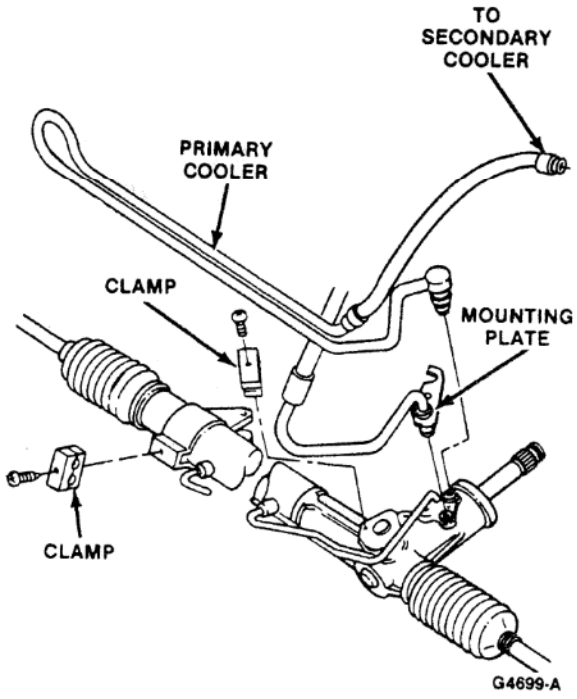
1. Connect the return hose to the secondary cooler and tighten the clamp.
2. Lower the vehicle.
3. Unplug the pump fitting (if necessary), connect the return hose to the pump and tighten the clamp.
4. Refill the power steering system. If necessary, refer to Section 13-51.

REMOVAL AND INSTALLATION (Continued)

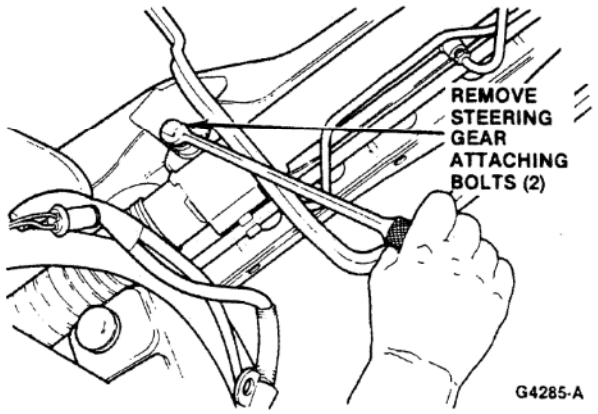
Primary Cooler

Removal

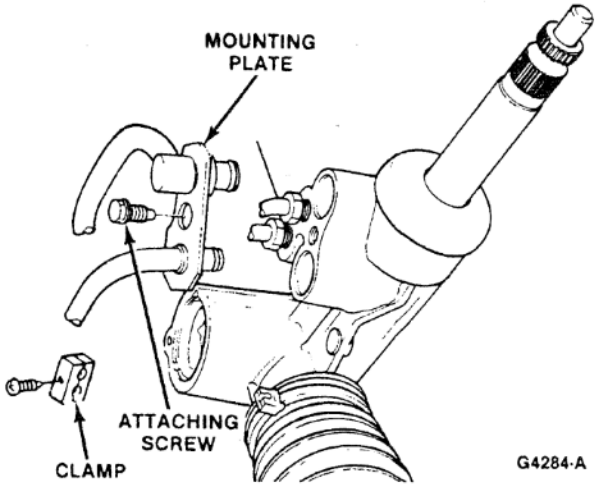
1. Raise the vehicle.



2. Place a drain pan under the steering gear.
3. Disconnect the primary cooler from the secondary cooler by disconnecting one end of the interconnecting hose.
4. Remove the steering gear mounting bolts and pull the gear away from the crossmember. Support the gear with wire attached to a convenient underbody component.
5. Remove the attaching screws and the clamps that attach the primary cooler to the steering gear.



6. Disconnect the pressure hose and the primary cooler from the steering gear by removing the washer-head screw securing the mounting plate assembly to the gear housing. Pull the assembly free and plug the housing ports to prevent the entry of contaminants.

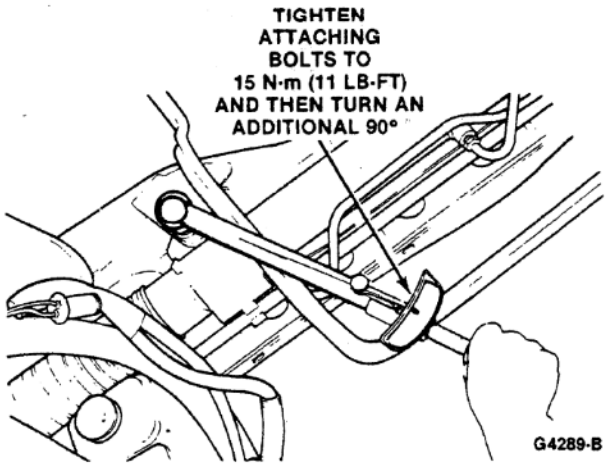


7. Disconnect the primary cooler from the mounting plate and remove it.

REMOVAL AND INSTALLATION (Continued)

Installation

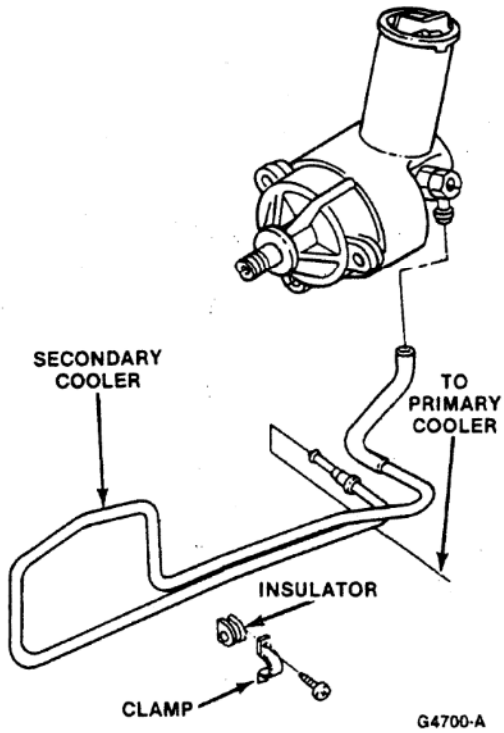
1. Insert the cooler in the mounting plate.
2. Install the mounting plate and lines into the steering gear ports and secure the plate with the washer-head screw.
3. Position the steering gear and install the mounting bolts. Tighten the bolts until snug (about 15 N·m or 11 lb-ft), then turn the bolts and additional 90°.



4. Install the clamps and attaching screws, attaching the primary cooler to the steering gear.
5. Connect the hose between the primary and secondary coolers.
6. Lower the vehicle.
7. Refill the power steering system. If necessary refer to Section 13-51.

Secondary Cooler

Removal and Installation



To remove the secondary cooler, raise the vehicle on a hoist and place a drain pan under the steering gear. Remove the screws and the clamps attaching the cooler to the frame. Disconnect the power steering pump return hose and the connecting hose to the primary cooler from the secondary cooler. Remove the secondary cooler. Installation is the reverse of removal. Refill the power steering system as necessary, as described in Section 13-51.

Seal Replacement and Inspection (Pump Quick-Connect Fitting)

The quick-connect power steering fitting at the pump may leak if the O-ring is cut or damaged, or if the sealing surfaces in the female port or in the O-ring groove on the hose assembly are improperly machined.

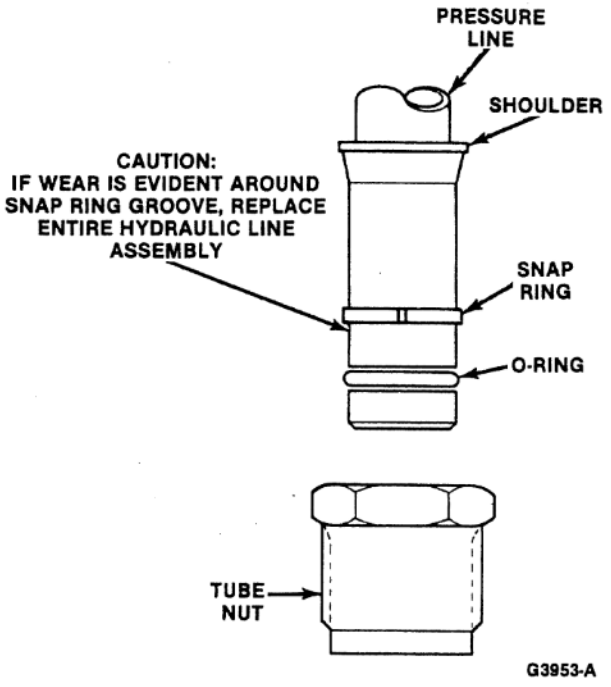
If a leak occurs, the O-ring should be replaced with quick-connect O-ring 388749-S.

NOTE: If O-ring replacement does not solve the leak problem, replace the female port first and then the hose assembly.

REMOVAL AND INSTALLATION

SEAL REPLACEMENT AND INSPECTION (PUMP QUICK-CONNECT FITTING) (Continued)

The quick-connect fitting at the pump may disengage if the snap ring is defective or if the tube nut is not properly machined. If disengagement occurs, the tube end may be serviced with a tube nut service kit containing a new tube nut, snap ring, and O-ring.



CAUTION: If wear is evident around the snap ring groove, replace the entire hose assembly.

The service snap ring must be installed with a minimum amount of deformation to the snap ring. After installation, the snap ring must not be distorted or bent and must rotate freely in the snap ring groove. If the hose assembly still does not engage, replace the hose assembly.

The system should then be properly filled, the engine started, and the steering wheel cycled from lock-to-lock to test for positive connector engagement.

Quick-connect hose assemblies for service have tube nuts, snap rings, and O-rings already attached.

SECTION 13-56 ZF POWER STEERING GEAR

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REMOVAL AND INSTALLATION 1
DISASSEMBLY AND ASSEMBLY 1

DESCRIPTION

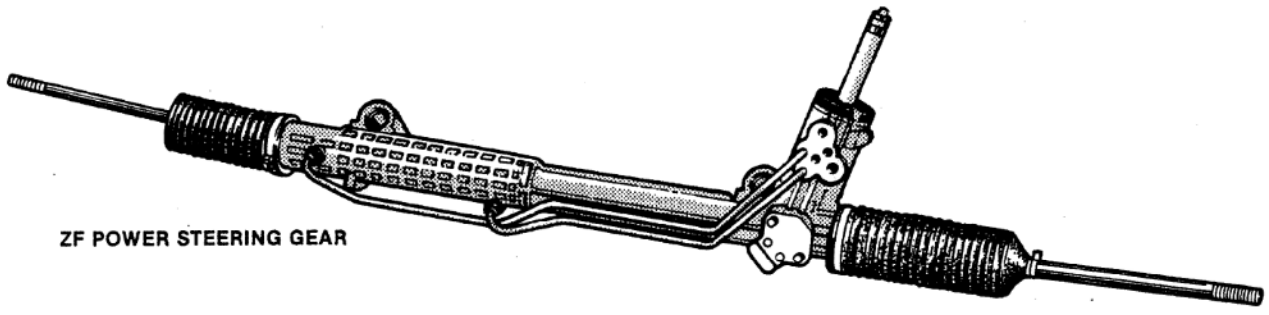
The construction and operation of the "ZF" steering gear is similar to that which is described in Section 13-46.

REMOVAL AND INSTALLATION

The removal and installation procedures for the "ZF" steering gear are similar to that which is outlined in Section 13-46.

DISASSEMBLY AND ASSEMBLY

If diagnosis indicates a problem exists in the "ZF" power steering gear, it must be replaced as an assembly. Individual components are not serviceable, with the exception of the tie rod ends, dust boots, transfer tubes and mounting insulators. The procedures found in Section 13-46 can be used to remove and install these components.



ZF POWER STEERING GEAR

G5126



GROUP 13 SPECIFICATIONS

STEERING GEAR DESIGN:

- Power assist rack and pinion
- Variable ratio—13.18-15.71
- Overall ratio—13.64

POWER STEERING PUMP: Ford CII

PUMP PRESSURE TEST SPECIFICATIONS:

- .95 gpm at 750 psi (engine at idle)
- 950-1130 psi relief pressure
- 2.1 gpm at 1500 rpm

TORQUE SPECIFICATIONS

Item	N·m	lb-ft
Steering column mounting bracket	18-22	13-16
Universal joint clamp	20-25	14-19
Tie rod to front spindle	20-32	15-23
Steering wheel to column shaft	45-55	33-40
Steering coupling pinch bolt	25-30	18-22
Steering gear to crossmember	15	11
	plus a 90° turn	

SUSPENSION

GROUP 14 (3000)

TITLE SECTION	PAGE NO.	TITLE SECTION	PAGE NO.

SUSPENSION DIAGNOSIS 14-01

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DIAGNOSTIC PROCEDURES
Inspection 4
Wheel Alignment 8

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Control Arm and/or
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Rear Axle and Suspension Assembly ... 13
Stabilizer Bar 16

GROUP 14

SPECIFICATIONS 1

SECTION 14-01 SUSPENSION DIAGNOSIS

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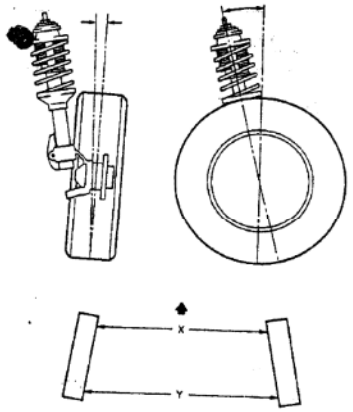
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GENERAL INFORMATION 1

TROUBLESHOOTING CHART—
SUSPENSION 2

DIAGNOSTIC PROCEDURES

Inspection 4
Wheel Alignment 8

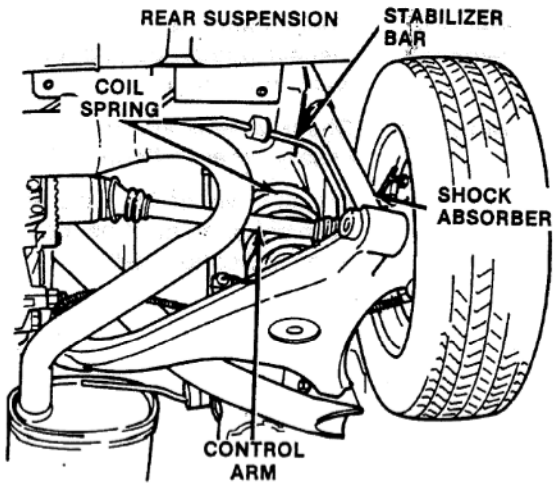


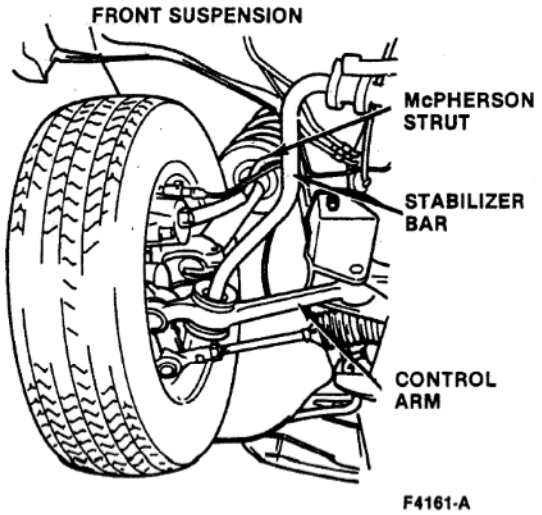
F4174-A

GENERAL INFORMATION

The suspension system, independently sprung front and rear, is designed for minimum maintenance. Only front-wheel toe-in is adjustable, all other suspension characteristics being established in vehicle design and manufacture. Other than incorrect front toe-in, suspension misalignment can only result from wear or damage to suspension parts, or distortion of the body structure due to collision damage.

Symptoms of suspension trouble include ride and handling problems, such as wander or pull to one side, erratic or hard steering, braking pull, dog-tracking, and excessive or uneven tire wear. Most of these symptoms can also be caused by factors outside the suspension, such as steering gear problems, brake drag, worn wheel bearings, mismatched tires, or abnormal vehicle load distribution. It is important to learn as much as possible about a complaint—when the condition was first noticed, whether it appeared suddenly or gradually, and if any impacts with curbs, potholes, etc. can be associated with it.





F4161-A

TROUBLESHOOTING CHART

SUSPENSION

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Wander/pull	Excessive side-to-side difference in caster or camber	Check alignment and if incorrect, inspect related components for wear or damage.
	Vehicle attitude incorrect (front or rear, high or low)	Check for abnormal loading, spring sag, or non-standard springs.
	Steering gear or linkage worn or defective	Check steering system. If necessary, refer to Section 13-01.
Hard steering	Excessive positive caster	Check caster and if incorrect, inspect related components for wear or damage.
	Vehicle attitude incorrect (front high or rear low)	Check for abnormal loading, spring sag, or non-standard springs.
	Steering gear or linkage worn, damaged or improperly adjusted	Check steering system. If necessary, refer to Section 13-01.
Brake pull	Excessive negative caster	Check caster and if incorrect, inspect related components for wear or damage.
	Unequal tire pressure	Inflate tires to correct and uniform pressure. If necessary, refer to Section 11-01.
	Brake drag	Check brakes. If necessary, refer to Section 12-01.
Shimmy	Excessive positive caster or side-to-side caster difference	Check caster and if incorrect, inspect related components for wear or damage.
	Wheel/tire imbalance or runout	Check wheels and tires. If necessary, refer to Section 11-01.
	Driveline vibration	Check driveline for imbalance or misalignment. If necessary, refer to Section 18-01.

CF4162-A1

TROUBLESHOOTING CHART

SUSPENSION (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Dog-tracking	Excessive side-to-side caster difference	Check caster and if incorrect, inspect related components for wear or damage.
	Rear suspension damage	If caster is uniform, check and compare wheelbase at right and left sides. If different, inspect suspension components and rear crossmember for wear or damage.
Uneven tire wear: Outer or inner shoulder	Excessive positive or negative camber	Check camber and if incorrect, inspect related components for wear or damage.
Sawtooth pattern or excessive tire wear	Excessive toe-in (high edges inboard) or toe-out (high edges outboard)	Check and adjust toe-in to specification. If necessary, refer to procedure in this section.
Cupping or dishing or excessive tire wear	Wheel/tire imbalance or runout	Check wheels and tires. If necessary, refer to Section 11-01.

CF4162-A2

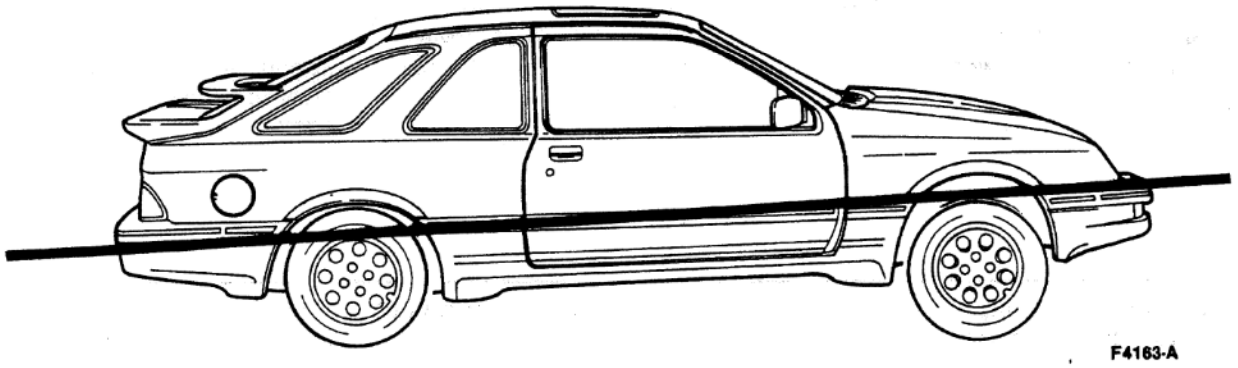
DIAGNOSTIC PROCEDURES

Diagnosis of possible suspension problems must start with a thorough inspection of the vehicle, including all suspension components and mounting points to identify any that are worn, damaged, or not securely installed.

INSPECTION

Suspension Height

Examine the vehicle for indications of abnormal attitude, such as front or rear end higher or lower than normal, or not level side-to-side. Check for extra-heavy items in luggage or passenger compartments, such as tool boxes, sample cases, etc. If present, they should be removed before checking wheel alignment. If vehicle attitude is not normal and no unusual load is present, check for signs of spring sag or damage, or non-standard replacement springs.



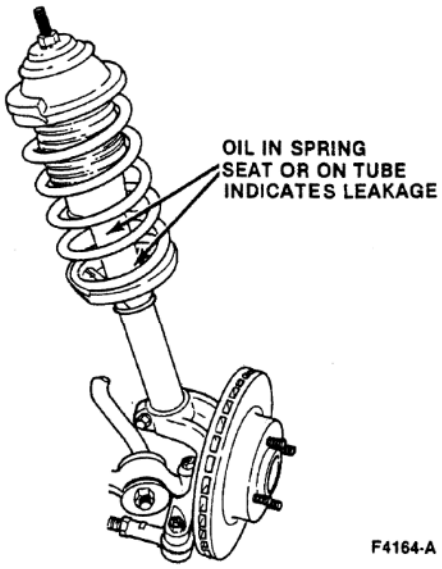
F4163-A

DIAGNOSTIC PROCEDURES

INSPECTION

Shock Absorbers/Struts

Bounce-test the vehicle at all four corners to check shock absorber function. Damping action should be pronounced and uniform. Inspect the shocks and struts for signs of leakage. A thin oily film is normal, but if a shock tube is conspicuously wet, or if oil is evident, the unit should be replaced. Also, check for looseness in the shock absorber or strut mounting bushings in the underbody or lower control arms. If any play is apparent, the bushings involved should be replaced.

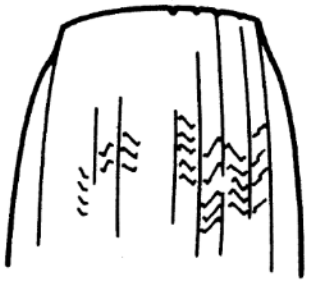


Tires

Verify that tires are matched from side-to-side, equally inflated and uniformly worn. Also, look for abnormal tread wear patterns indicative of wheel/tire imbalance or suspension misalignment. If cupping or flat spots are present, wheels and tires should be checked for runout and balance. If necessary, refer to Section 11-01.

If tread wear is not uniform across the face of the tire, but greater toward the inboard or outboard edges, improper camber is indicated, which will be verified by an alignment check. Since camber is not adjustable, any deviation from specification limits is indicative of worn or damaged suspension components.

Tread wear in a sawtooth pattern, which can be felt even if not visible, results from improper toe adjustment. If the high edges of the tread ribs are toward the vehicle center, excessive toe-in is indicated. If away from the vehicle center, toe-out is excessive.



ABNORMAL WEAR DUE TO EXCESSIVE POSITIVE CAMBER



SAWTOOTH WEAR PATTERN DUE TO EXCESSIVE TOE-IN

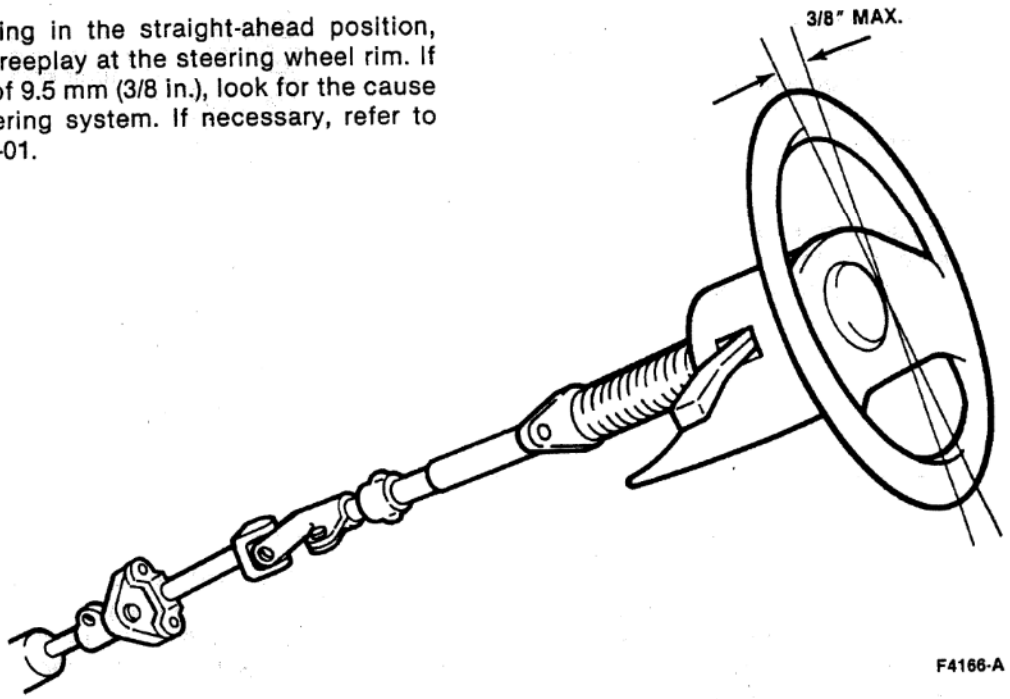
F4165-A

DIAGNOSTIC PROCEDURES

INSPECTION

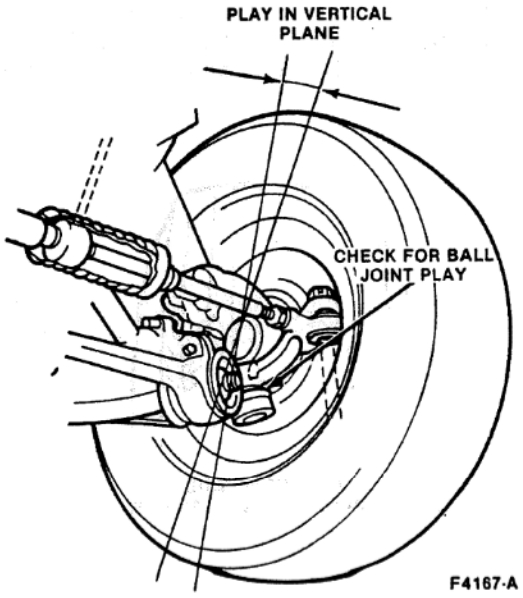
Steering Wheel Play

With steering in the straight-ahead position, check for freeplay at the steering wheel rim. If in excess of 9.5 mm (3/8 in.), look for the cause in the steering system. If necessary, refer to Section 13-01.



Ball Joints

Lift the vehicle with a jack under the front crossmember, until the front wheel is clear of the floor, and try to rock the wheel in a vertical plane. If any play is felt, have an assistant rock the wheel while observing the ball joint in the lower control arm, at the bottom of the spindle carrier. If any movement is detectable between spindle carrier and control arm, the control arm assembly should be replaced. If not, any play in the wheel is indicative of wheel bearing wear. If necessary, refer to Section 11-16 for wheel bearing service procedures.

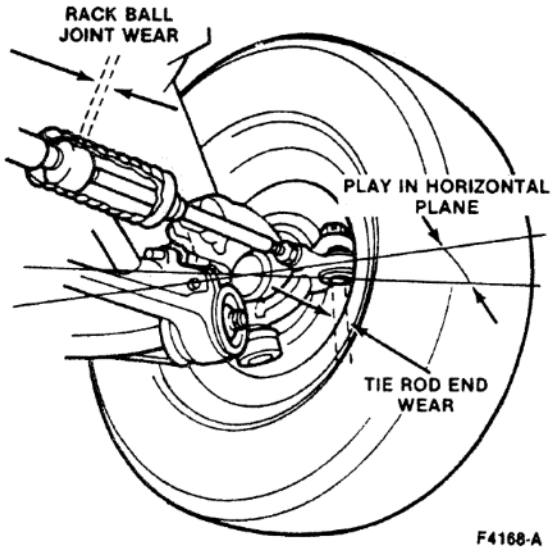


DIAGNOSTIC PROCEDURES (Continued)

Inspection

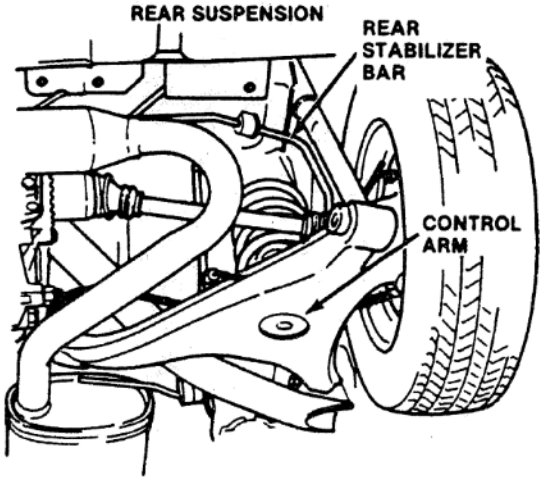
Tie Rods

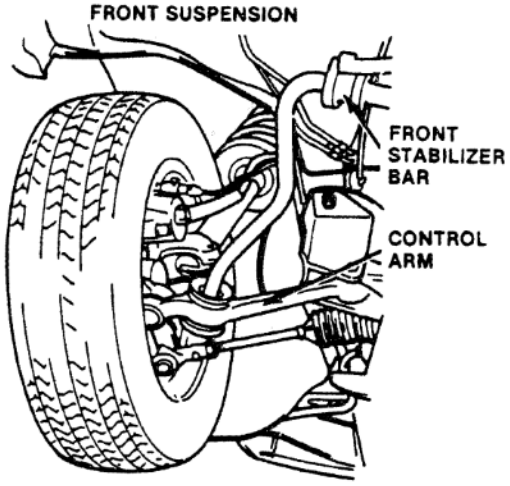
With one front wheel raised, try to rock it in the horizontal plane with the opposite wheel grounded or blocked. If any play is felt, check the tie rod end ball joint for relative motion. If any is present, replace the tie rod end. Hold the opposite wheel tie rod, while rocking the wheel horizontally, to detect any endplay present in the steering rack ball joints. If necessary, refer to Section 13-46 for steering gear repairs.



Control Arms and Stabilizers

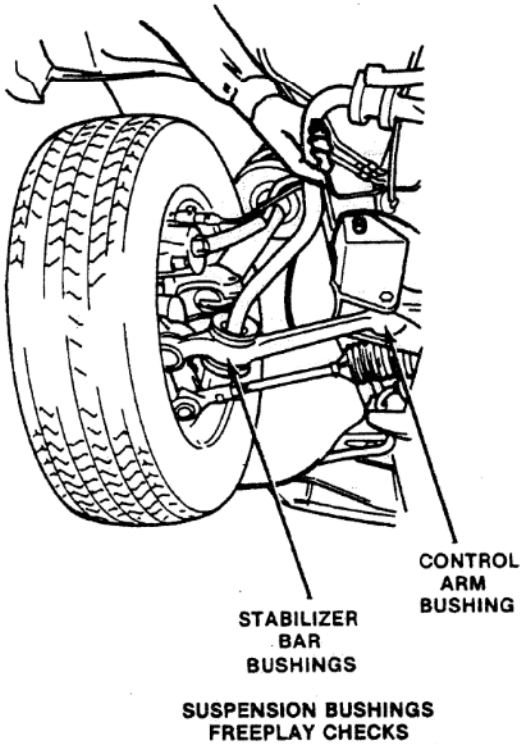
Inspect control arms of both front and rear suspensions for signs of damage due to curb impacts, improper hoist positioning, etc. If present, check for bending by carefully measuring and comparing critical dimensions of right and left arms. Also, pay special attention to the front suspension stabilizer bar, the outer legs of which act as radius struts controlling lower arm position, and therefore caster angle. These legs must be symmetrical and equal in length from frame mounting points to lower arm bushings.If bent or sprung out of alignment, the stabilizer bar must be replaced.





DIAGNOSTIC PROCEDURES (Continued)

Test all rubber-bushed suspension mounting and connecting points for freeplay in the unloaded condition. Use a jack or lever to raise the vehicle or suspension component so as to unload the bushing for shake-testing. Some restrained relative motion is permissible as the bushing is stressed in testing, but if freeplay is evident at any point, the bushing should be replaced.



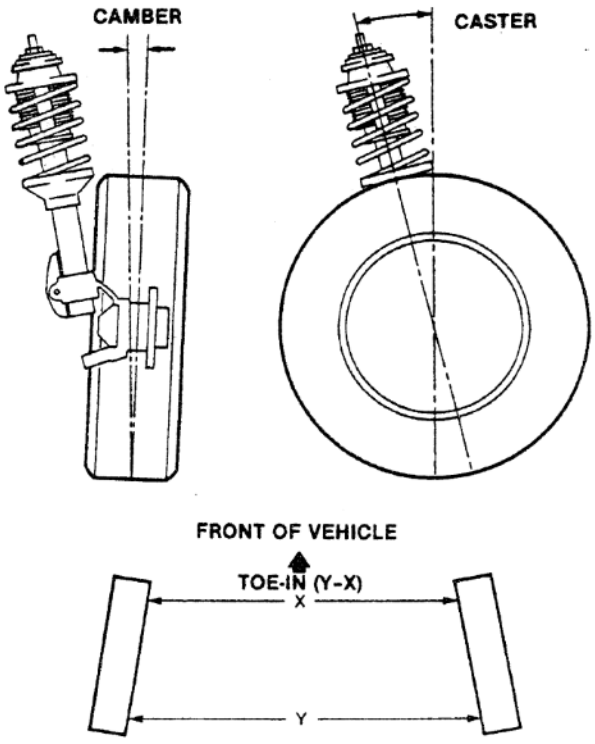
SUSPENSION BUSHINGS FREEPLAY CHECKS

F4170-A

Wheel Alignment

Caster and Camber

While caster and camber are not adjustable, they should be checked as possible causes of suspension complaints. Be sure the tires are correctly and uniformly inflated, and any abnormal loads are removed from the vehicle. If caster or camber are not within limits (refer to Group 14 Specifications) and control arms, stabilizers and bushings are in good condition, check the vehicle body for distortion at suspension mounting points, due to collision damage, curb or pothole impacts, improper hoisting, etc.



F4171-A

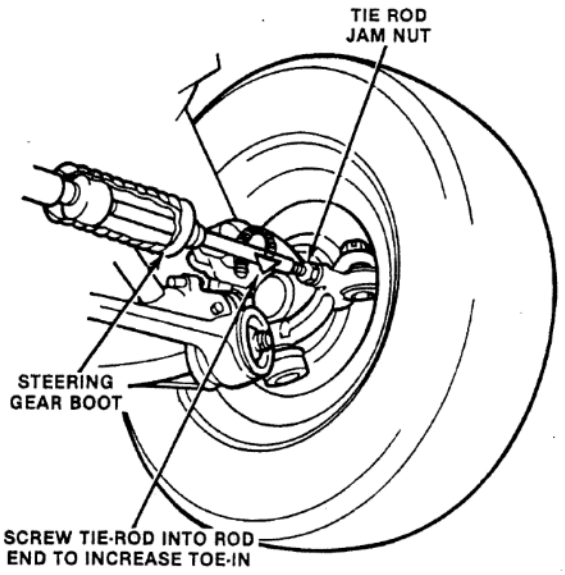
DIAGNOSTIC PROCEDURES

WHEEL ALIGNMENT

Toe-in Adjustment

Check toe-in against specifications −0.5 mm (1/64 inch) toe-out to 4.5 mm (3/16 inch) toe-in. If not within limits, adjust to 2 mm toe-in (5/64 inch) ±1 mm (1/32 inch) as follows:

1. Loosen the jam nuts at the tie rod ends, and release the clips at the small ends of the steering gear boots. Be sure the boots are free on the tie rods so that they won't be twisted when the tie rods are turned.
2. Turn the tie rods into or out of the tie rod ends an equal amount on each side, to keep the steering wheel centered. Since the steering gear and tie rod connections are forward of the front wheel spindles, the tie rods must be shortened, that is, screwed INTO the tie rod ends, to increase toe-in.
3. When toe-in is correct, tighten the tie rod end jam nuts to 57-68 N·m (42-50 ft-lb). Verify that the steering gear boot ends are positioned in the reduced-diameter sections of the tie rods and install the boot clips.



F4172-A

Centering the Steering Wheel

If the steering wheel is not properly centered when the vehicle is driven straight ahead, mark its position with a piece of tape across the gap between steering wheel hub and steering column shroud. Cut the tape at the gap to permit steering wheel operation after marking.

If the steering gear has been serviced, a lock-to-lock centering check is advisable to be sure the gear is correctly assembled. If necessary, refer to Section 13-46.

If toe-in is to be adjusted also, the operation can be combined with steering wheel centering but, to avoid complications, one should be completed before starting the other. To center the steering wheel, the tie rods must be turned into one tie rod end and out of the other, in equal amounts to avoid changing the toe setting. This shifts the steering rack right or left, turning the pinion, steering column and wheel to the desired position.

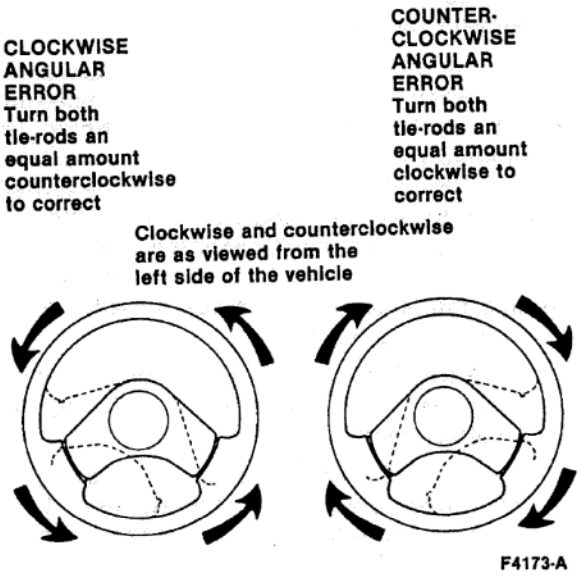
1. Mark the tie rods and tie rod ends with paint or grease pencil to indicate their original relative positions.
2. Loosen and back off the tie rod end jam nuts and release the steering gear boot clips. Be sure the boots are free on the tie rods to avoid twisting.
3. Screw the tie rods into one tie rod end and out of the other, depending on which way the steering wheel is to be moved and how much. For example, if the left tie rod is screwed in and the right tie rod out, the steering rack moves to the left and the steering wheel movement is counterclockwise as seen from the driver's seat. For clockwise correction, the rack must be moved to the right. If the road wheels are positioned and locked in the straight-ahead position during this operation, using the steering wheel tape mark as a starting point, the wheel will turn during adjustment, and the centered position can be judged visually. One revolution of the tie rods will result in a steering wheel correction of about 19 degrees. Check the marks on tie rods and tie rod ends to be sure the tie rods are turned equal amounts.

DIAGNOSTIC PROCEDURES

WHEEL ALIGNMENT

Centering the Steering Wheel (Continued)

4. If toe-in is to be adjusted, turn BOTH tie rods in or out BY EQUAL AMOUNTS before locking the jam nuts. Torque the jam nuts to 57–68 N·m (42–50 ft-lb), position the boot ends in the tie rod undercuts, and install the boot clips.



NOTE: It is vitally important that the tie rods are rotated the same amount in the same direction otherwise the toe settings will be disturbed.

Example: Steering wheel angular error = 3° to the right (clockwise).

Tie rods must be rotated $3 \times 19° = 57°$ in an anti-clockwise direction when viewed from the left-hand side of the vehicle.

SECTION 14-10 FRONT SUSPENSION

CONTENTS

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DESCRIPTION 1

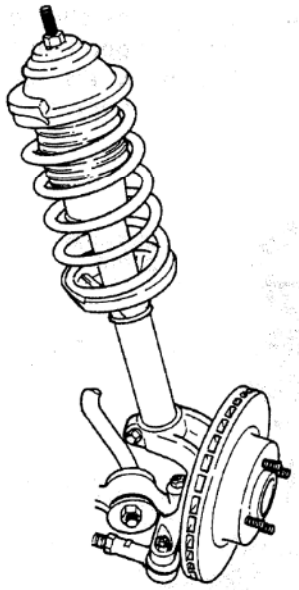
REMOVAL AND INSTALLATION

Control Arm and/or Stabilizer Bar Bushings 3
Control Arm Bushing 5
Stabilizer Bar 6
Strut 10
Top Mount Insulator 12
Crossmember 14

DISASSEMBLY AND ASSEMBLY

Strut 18

COMPONENT INSPECTION CHART 20

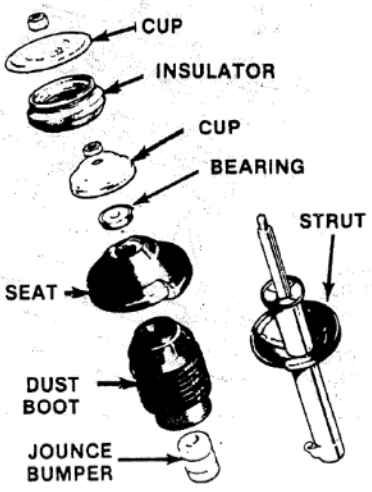


F3981-A

DESCRIPTION

The front of the XR4Ti is suspended on coil springs and shock absorbers which are combined into two assemblies referred to as McPherson struts. The shock absorber shaft extends upward through the shock tower where the top mount attaches it to the body. The shock absorber cylinder is the other attachment point for the strut. The cylinder is installed in the top of the spindle carrier where a pinch bolt clamps it in position. To locate the strut in the spindle carrier, a hook on the inboard side of the strut engages the pinch bolt.

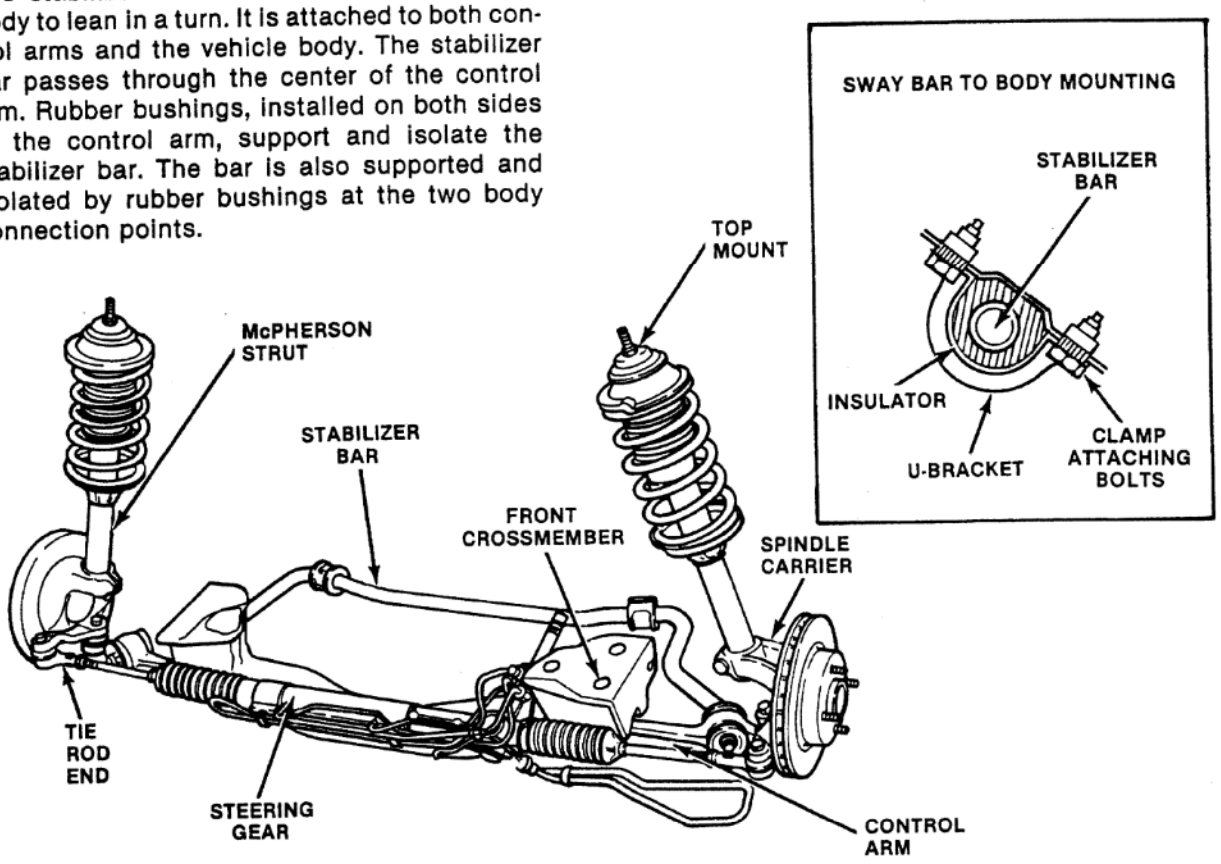
Control arms are used to connect the spindle carriers to the crossmember. The arms are attached to the crossmember with pivot bolts that allow the arms to move up and down with the strut and spindle assemblies. Bushings, pressed into the ends of the arms, isolate the control arms from the pivot bolts and vehicle body. The opposite ends of the control arms contain a ball joint. The joints provide pivot points for the spindle and strut assemblies during a turn.

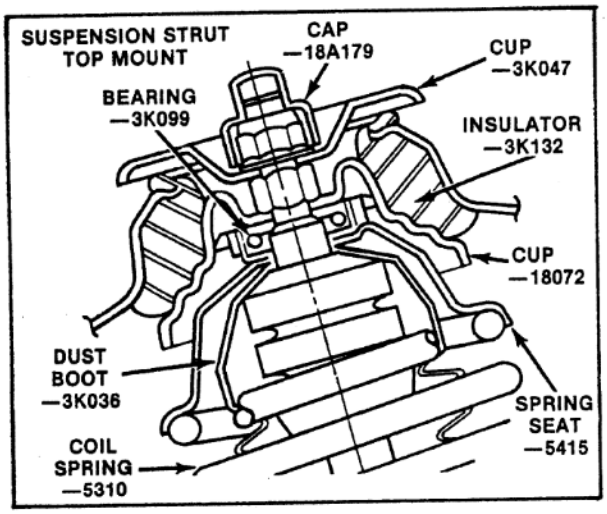


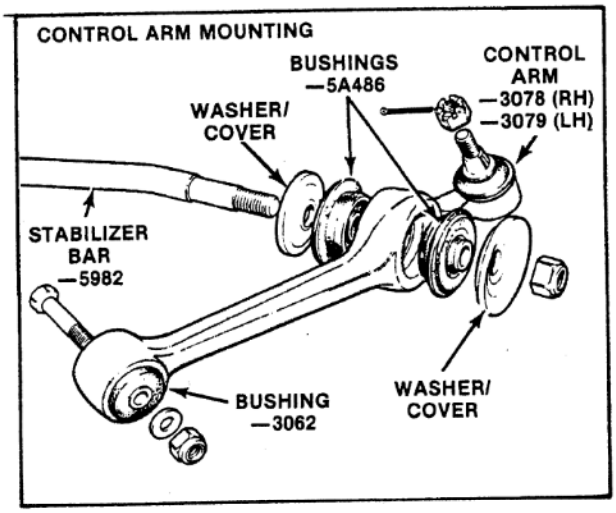
F3981-A

DESCRIPTION

The stabilizer bar limits the tendency of the body to lean in a turn. It is attached to both control arms and the vehicle body. The stabilizer bar passes through the center of the control arm. Rubber bushings, installed on both sides of the control arm, support and isolate the stabilizer bar. The bar is also supported and isolated by rubber bushings at the two body connection points.







F4155-A

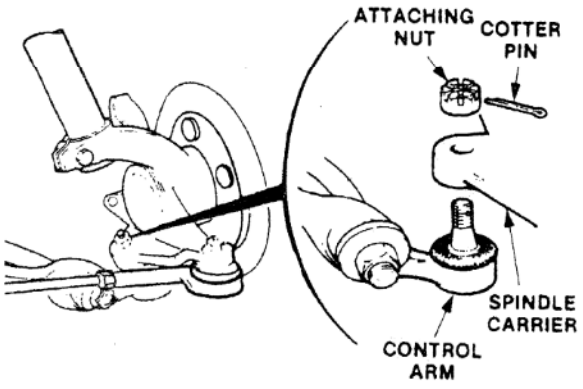
REMOVAL AND INSTALLATION

Control Arm and/or Stabilizer Bar Bushings

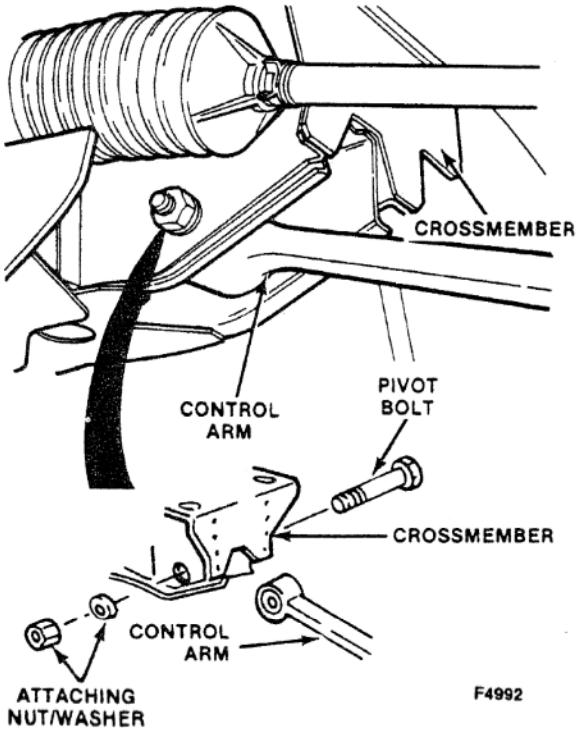
Removal

1. Remove the cotter pin and attaching nut and separate the control arm from the spindle carrier.

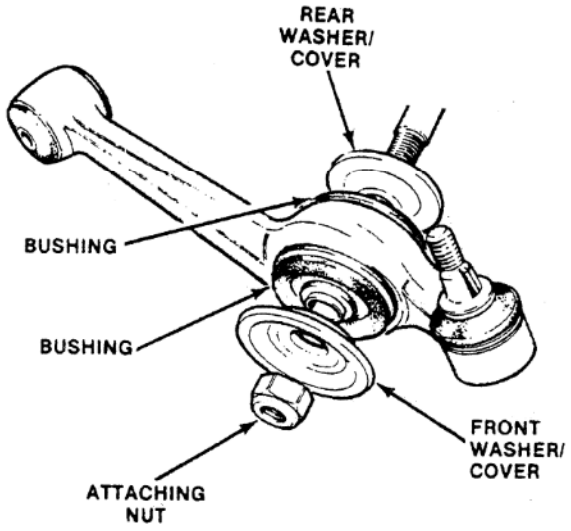
CAUTION: With the spindle carrier and control arm disconnected, the spindle carrier can easily cause damage to the control arm ball joint boot.



2. Remove the pivot bolt attaching the control arm to the crossmember.



3. Remove the nut attaching the stabilizer bar to the control arm.
4. Remove the front washer/plastic cover, from the end of the stabilizer bar.



5. Remove the control arm and bushings as an assembly.
6. Remove the rear washer/plastic cover from the end of the stabilizer bar.
7. If necessary, remove the bushings from the control arm. The bushings are pressed into the arm.

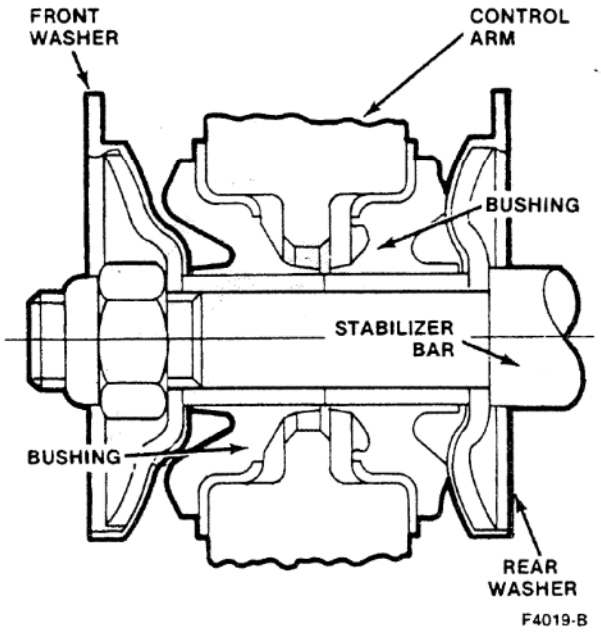
Installation

NOTE: The stabilizer bar bushings are designed to allow the control arm to move forward and rearward somewhat.

1. If necessary, install the stabilizer bar bushings in the control arm using a press.
2. Install the rear washer/plastic cover on the stabilizer bar.

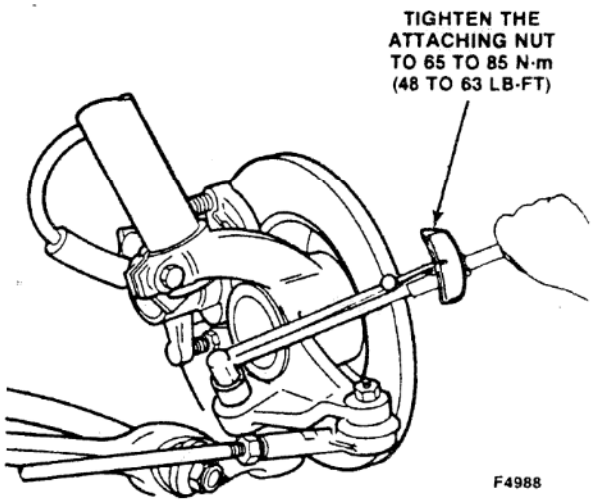
REMOVAL AND INSTALLATION (Continued)

NOTE: The rear washer has a shallower dish than the front washer. When the washer is installed, make sure the plastic cover is in place between the dished steel washer and the bushing and that the dished side of the steel washer faces away from the bushing.



3. Install the control arm and bushing assembly on the stabilizer bar.
4. Install the front washer/plastic cover on the stabilizer bar.

   Be sure the dished side of the washer faces away from the bushing, as described in the above note.
5. Install the stabilizer bar attaching nut. Snug the attaching nut but do not tighten.
6. Position the control arm ball joint stud in the spindle carrier and install the attaching nut. Tighten the attaching nut to 65 to 85 N·m (48 to 65 lb-ft). Install the cotter pin.



NOTE: If the slots in the nut do not align with the cotter pin hole, tighten the nut to the next slot. **Never loosen the nut for alignment.**

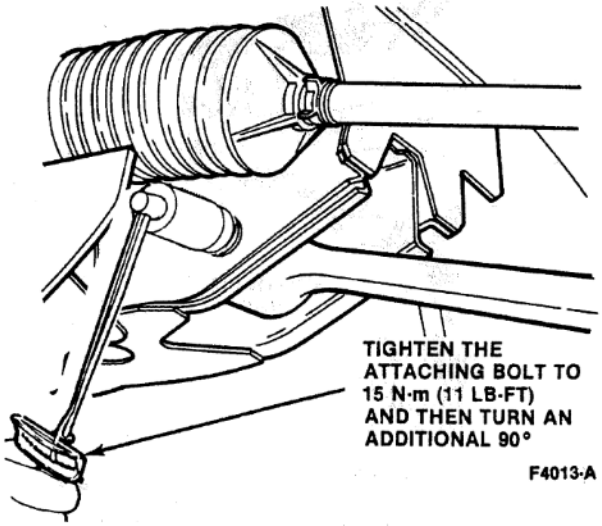
7. Grip the bottom of tire and pull inward until the control arm enters the crossmember and aligns with the bolt holes. Use a drift punch to hold the arm in alignment while the attaching bolt is installed.
8. Install the control arm pivot bolt, plain washer and attaching nut. Snug the attaching nut but do not tighten.
9. Lower the vehicle.

REMOVAL AND INSTALLATION

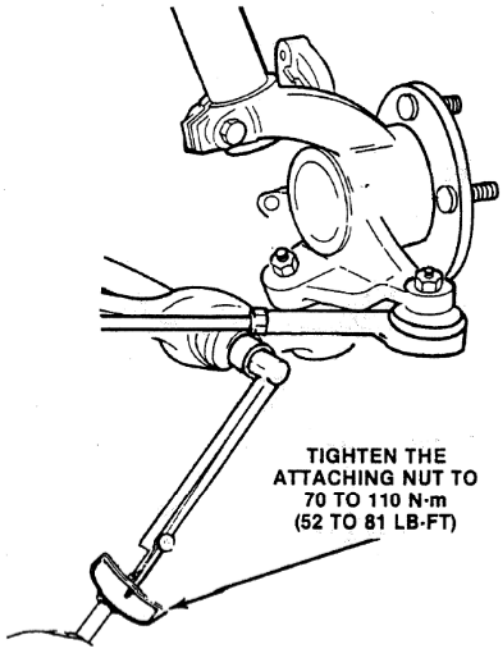
CONTROL ARM AND/OR STABILIZER BAR BUSHINGS

Installation (Continued)

10. With the vehicle weight on the tires:
    - Tighten the control arm pivot bolt nut to 15 N·m (11 lb-ft) and then turn an additional ninety degrees.



- Tighten the stabilizer bar attaching nut to 70 to 110 N·m (52 to 81 lb-ft).



CONTROL ARM BUSHING

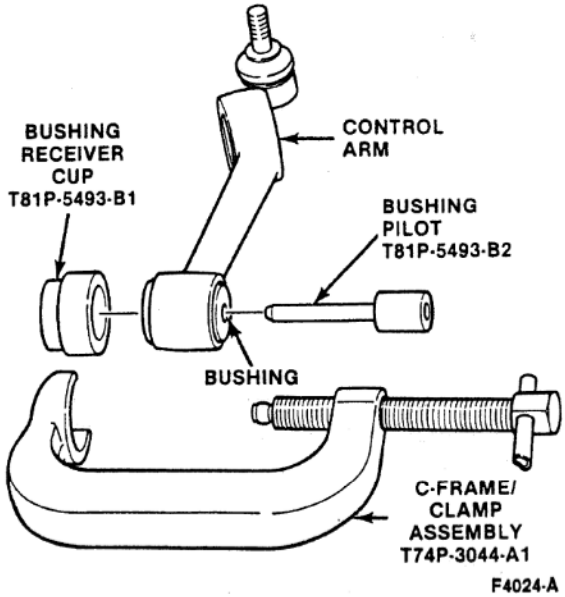
Removal

SPECIAL SERVICE TOOLS REQUIRED:

Bushing Receiver Cup	T81P-5493-B1
Bushing Pilot	T81P-5493-B2
Bushing Replacer Cup	T81P-5493-B3
C-Frame/Clamp Assembly	T74P-3044-A1

1. Remove the control arm. If necessary, refer to the procedure in this section.

2. Remove the control arm bushing, using Bushing Receiver Cup T81P-5493-B1, Bushing Pilot T81P-5493-B2, and C-Frame/Clamp Assembly T74P-3044-A1, or equivalents.



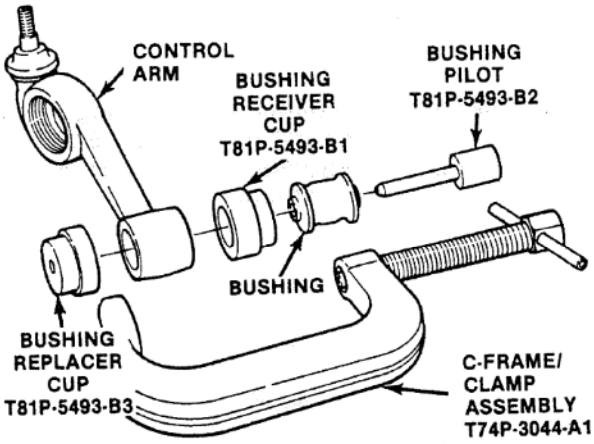
REMOVAL AND INSTALLATION

CONTROL ARM BUSHING

Installation

1. Coat the control arm bore and outer surface of the bushing with glycerine lubricant.

2. Install the control arm bushing, using Bushing Replacer Cup T81P-5493-B3, Bushing Pilot T81P-5493-B2 and C-Frame/Clamp Assembly T74P-3044-A1, or equivalent.



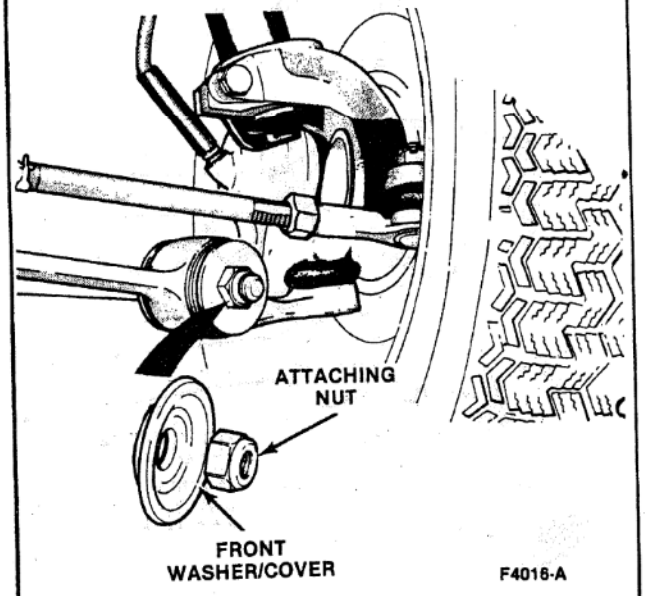
NOTE: Insert the bushing quickly and with a continuous motion so that the bushing deforms for only a short time.

3. Install the control arm. If necessary, refer to the procedure in this section.

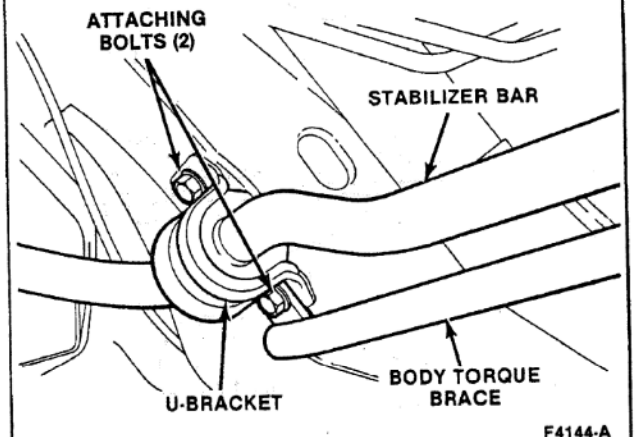
STABILIZER BAR

Removal

1. Remove the attaching nuts and front washers/covers from the ends of the stabilizer bar.

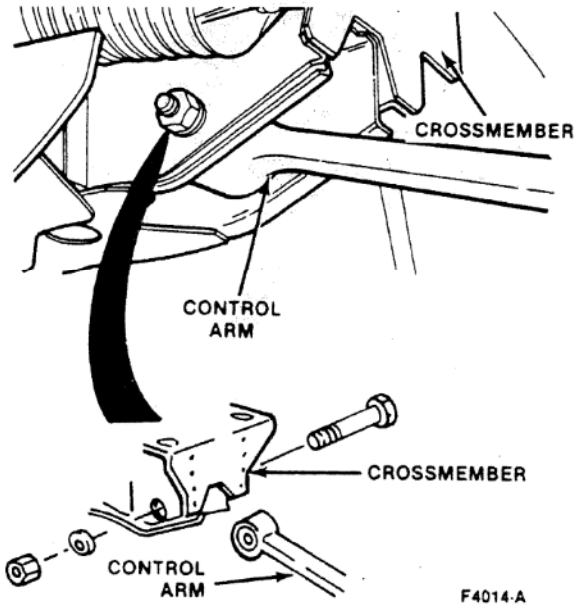


2. Remove the four bolts securing the two U-brackets and torque brace to the body.

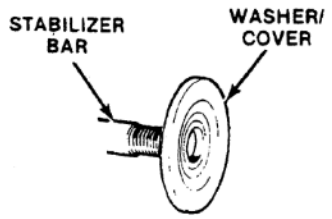


REMOVAL AND INSTALLATION (Continued)

3. Detach one control arm pivot bolt and pull the control arm out of the crossmember.



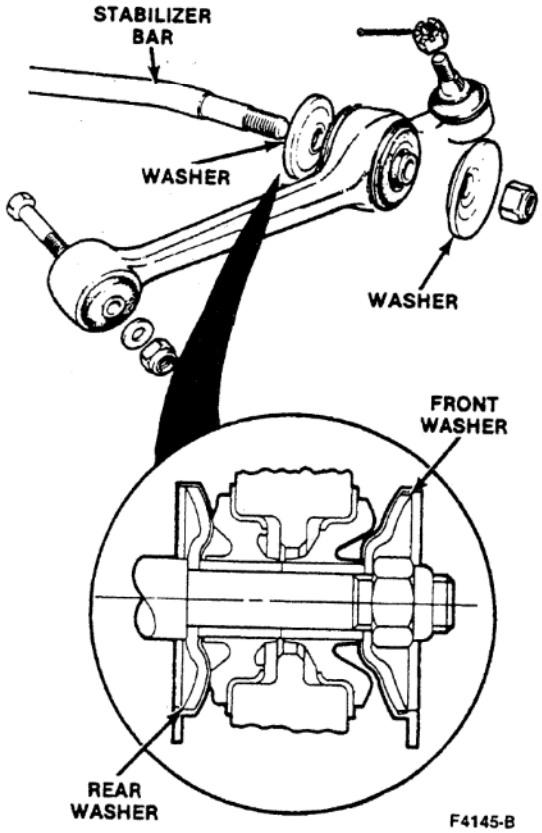
4. Pull the stabilizer out of the lower control arms and remove from the vehicle.
5. Remove the rear washers/covers from the stabilizer bar.



6. Remove the insulators from the stabilizer bar.

Installation

1. Coat the inside of the stabilizer bar bushings and the bushing surfaces on the stabilizer bar with glycerine. Install the body insulators on the stabilizer bar.
2. Install the rear washers/plastic covers on the stabilizer bar.

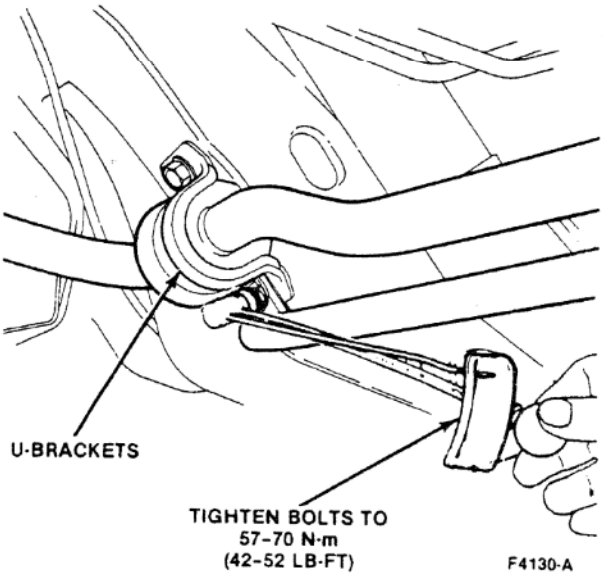


NOTE: The rear washer has a shallower dish than the front washer. When the washer is installed, make sure the plastic cover is in place between the dished steel washer and the bushing and that the dished side of the steel washer faces away from the bushing.

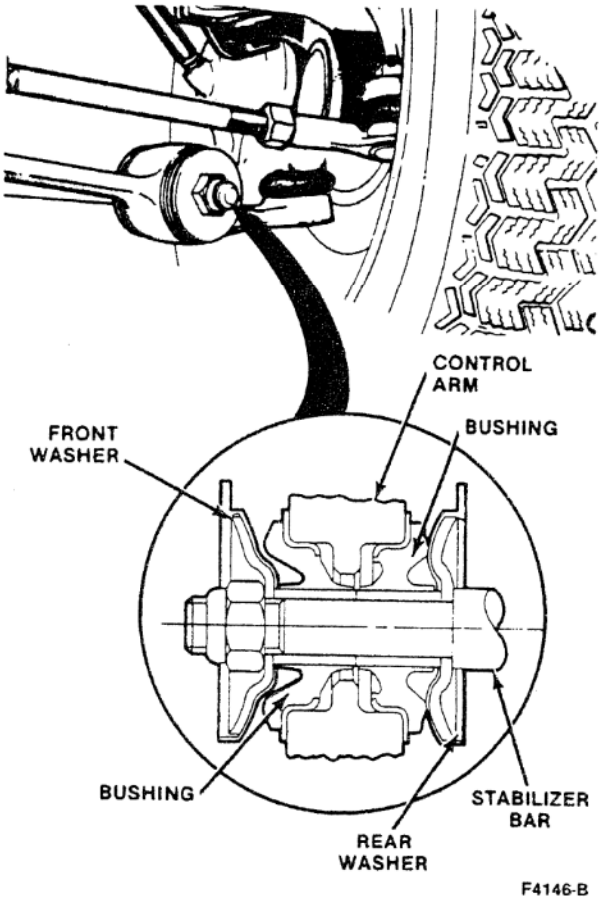
REMOVAL AND INSTALLATION (Continued)

3. Install the stabilizer bar into the control arms bushings and install the control arm into the crossmember with the pivot bolt, washer and nut. Snug the attaching nut but do not tighten.
4. Install the U-brackets on the insulators and install the attaching bolts.

   Tighten the attaching bolts to 57 to 70 N·m (42 to 52 lb-ft).



5. Install the front washers/plastic covers on the stabilizer bar.



NOTE: Make sure the dished side of the steel washer faces away from the bushing, with the plastic cover in place between the bushing and the steel washer.

6. Install the stabilizer bar attaching nuts.

   Snug the nuts but do not tighten the attaching nuts.

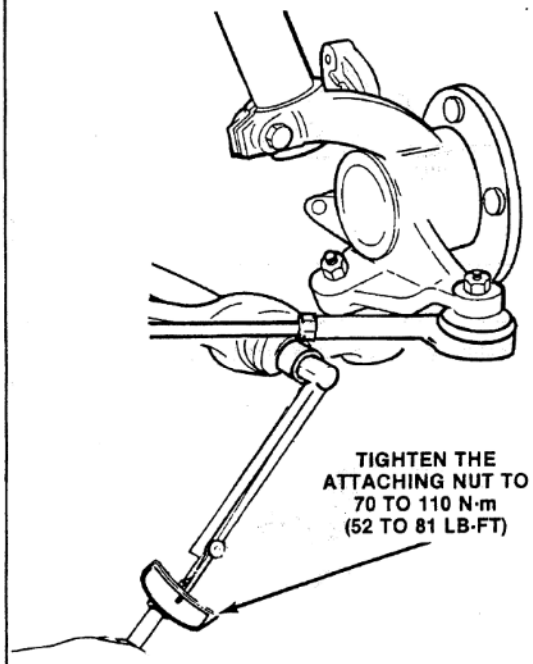
REMOVAL AND INSTALLATION

STABILIZER BAR

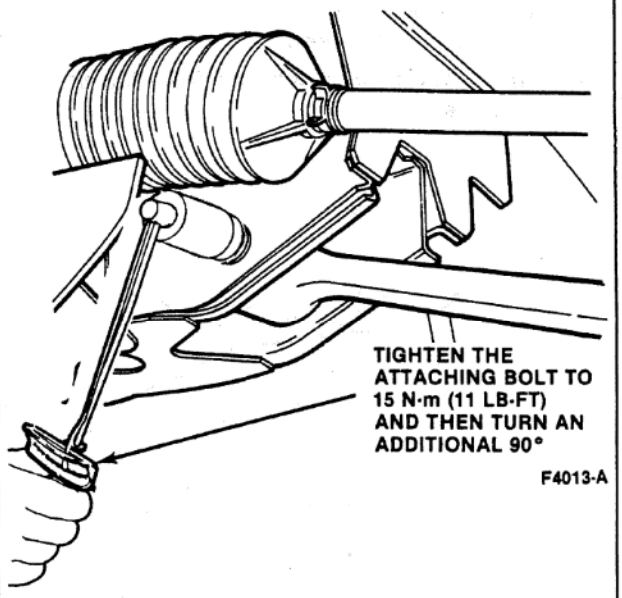
Installation (Continued)

7. Lower the vehicle.

8. With the vehicle weight on the tires, tighten the stabilizer bar attaching nut to 70 to 110 N·m (52 to 81 lb-ft).



- Tighten the control arm pivot bolt nut to 15 N·m (11 lb-ft) and then turn an additional ninety degrees.



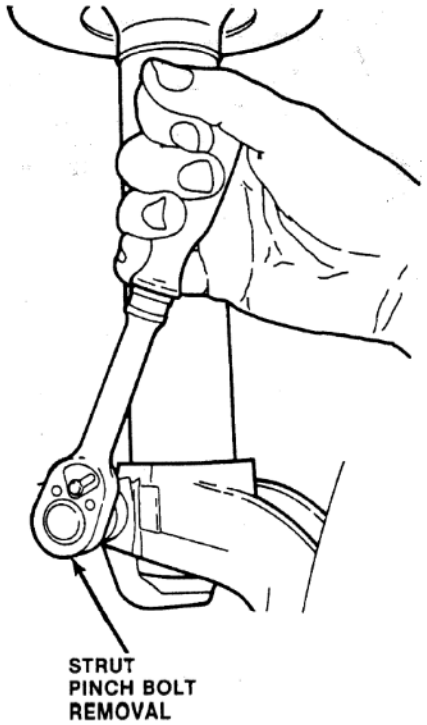
REMOVAL AND INSTALLATION

STRUT

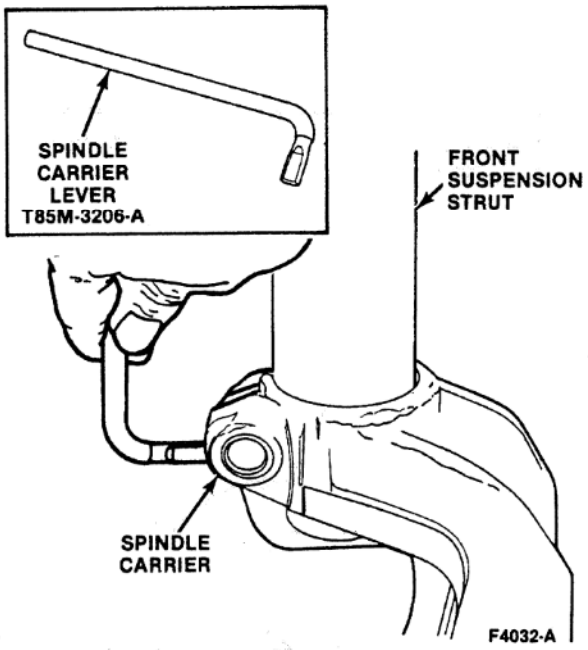
Removal

NOTE: If a twin post hoist is used to perform this procedure, the front of the vehicle must be supported on safety stands to allow lowering of the front post. If the front post is not lowered, the lower control arm can contact the hoist preventing removal of the strut.

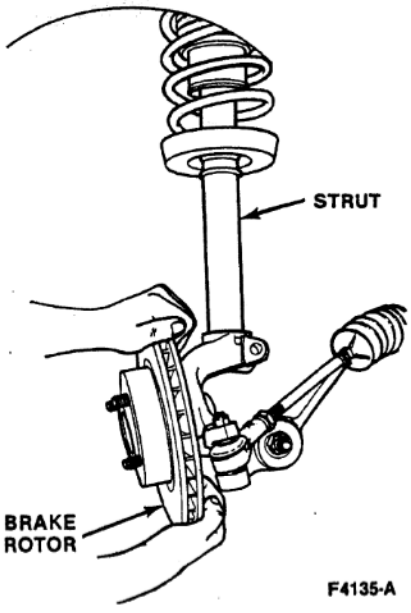
1. Remove the wheel and raise the vehicle.
2. Remove the disc brake caliper anchor attaching bolts. Remove the caliper/anchor assembly and wire aside.
3. Remove the bolts retaining the stabilizer bar mounting brackets.
4. Remove the strut pinch bolt from the spindle carrier.



5. Insert Spindle Carrier Lever T85M-3206-A into the slot in the spindle carrier and rotate it through ninety degrees to open the slot.



6. Pry downward, to disengage the spindle carrier from the strut.



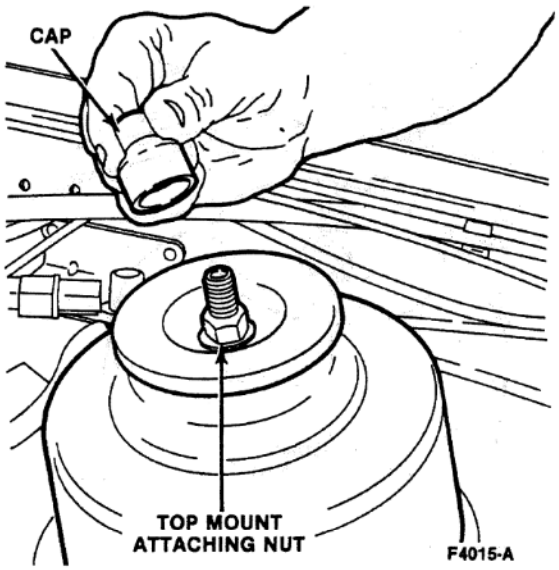
REMOVAL AND INSTALLATION

STRUT

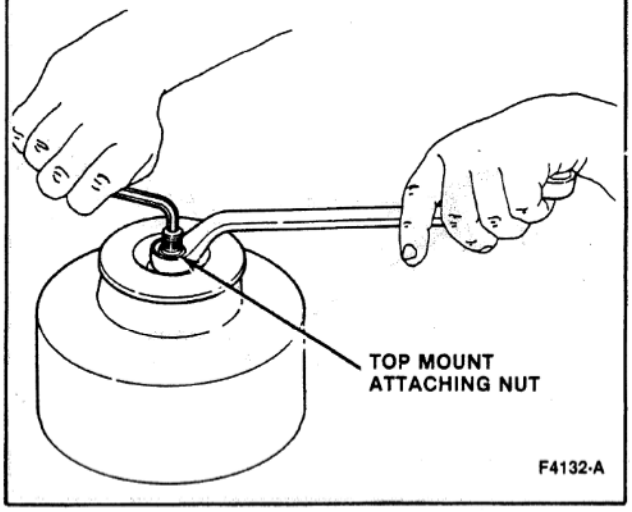
Removal (Continued)

CAUTION: When releasing the spindle carrier from the strut, place a jack under the control arm bushing boss to keep the spindle carrier from being pushed down too far.

7. Remove the cap from the top mount attaching nut.



8. While holding the piston shaft with a 6 mm allen wrench, loosen the top mount attaching nut.



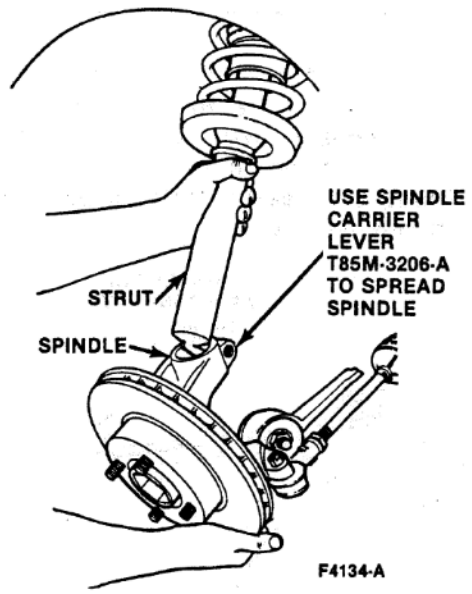
9. Support the strut from below and remove the top mount nut, retainer and strut.

   Discard the nut.

Installation

1. Position the strut through the top mount insulator. Install the retainer and a new top mount attaching nut. Do not tighten the nut.

2. To position the strut in the spindle, pull outward on the strut and lift the spindle using the brake rotor. Use Spindle Carrier Lever T85M-3206-A to spread the spindle carrier to allow the strut to center correctly. When the strut enters the spindle, grip the rotor and pivot the spindle into position.



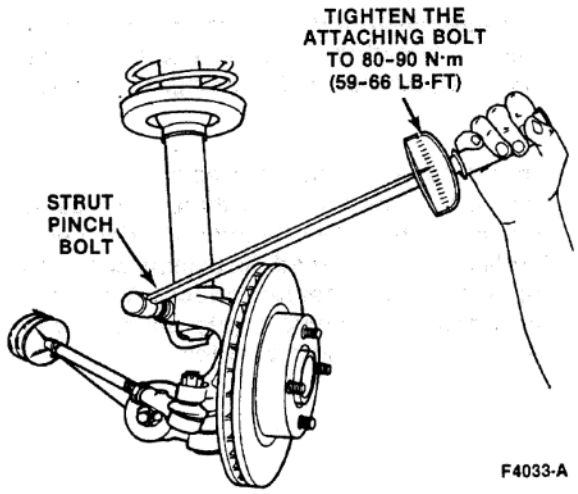
NOTE: If the strut is not pulled outward to match the spindle angle, it will jam as the spindle is pivoted into position.

REMOVAL AND INSTALLATION

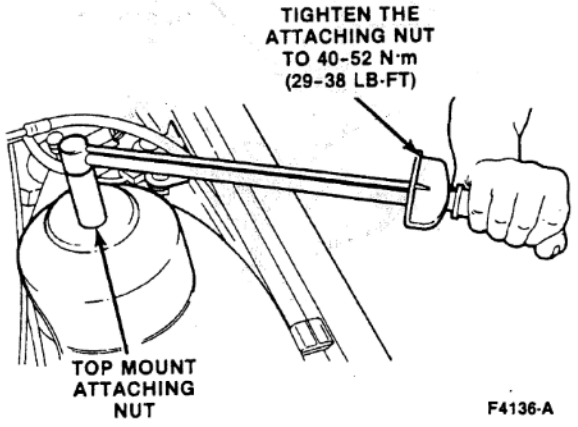
STRUT

Installation (Continued)

3. Install the strut pinch bolt. Tighten the pinch bolt to 80 to 90 N·m (59 to 66 lb-ft).
4. Install the bolts retaining the stabilizer bar mounting brackets.
5. Install the disc brake caliper.



6. Make sure the top of the strut is centered in the suspension tower and tighten the top mount attaching nut to 40 to 52 N·m (29 to 38 lb-ft). If necessary, hold the piston shaft with a 6 mm allen wrench.

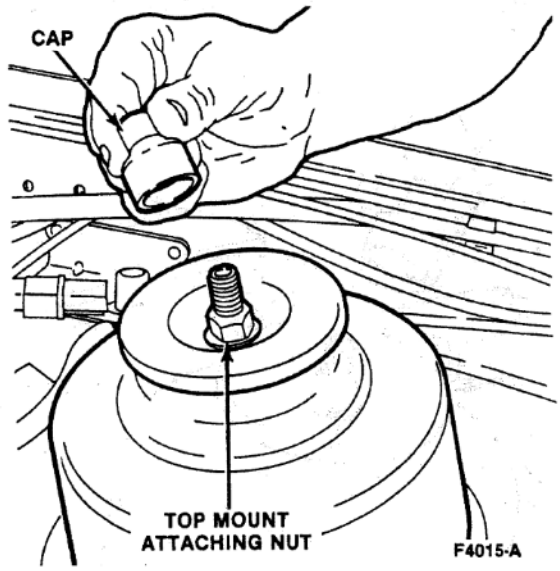


7. Install the cap on the top mount attaching nut.
8. Install the wheel.

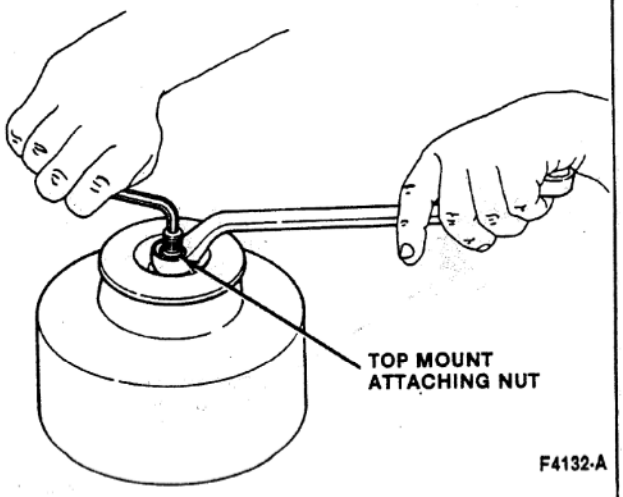
TOP MOUNT INSULATOR

Removal

1. Remove the cap from the top mount attaching nut.



2. While holding the piston shaft with a 6 mm allen wrench, remove and discard the top mount attaching nut.

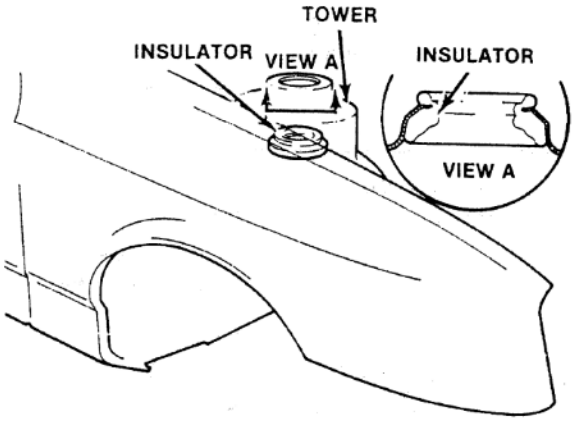


REMOVAL AND INSTALLATION

TOP MOUNT INSULATOR

Removal (Continued)

3. Remove the retainer from the piston shaft.
4. Using a pry bar, force the suspension assembly downward. Do not lower the suspension assembly so low that the brake hose could stretch.
5. Remove the top mount insulator.

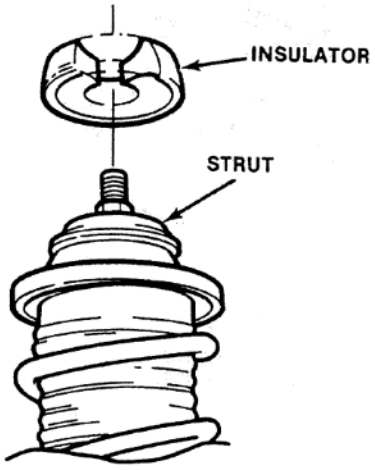


F4138-A

Installation

1. Fit the insulator into the suspension tower.
2. Position the suspension assembly in the suspension tower.
3. Position the retainer on the piston shaft.

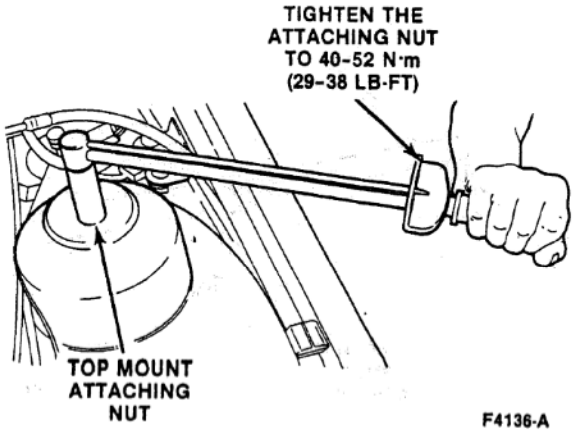
NOTE: Make sure the top of the strut is centered in the suspension tower before installing the retainer and attaching nut.



F4139-A

4. Install a new top mount attaching nut.

   Tighten the attaching nut to 40 to 52 N·m (29 to 38 lb-ft). If necessary, hold the piston shaft with a 6 mm allen wrench.



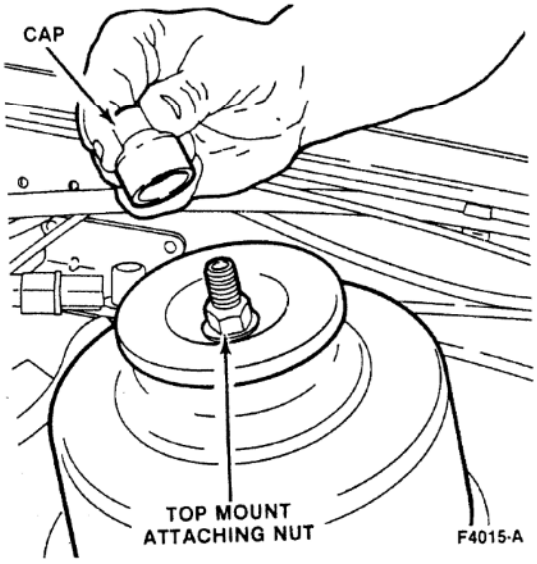
F4136-A

REMOVAL AND INSTALLATION

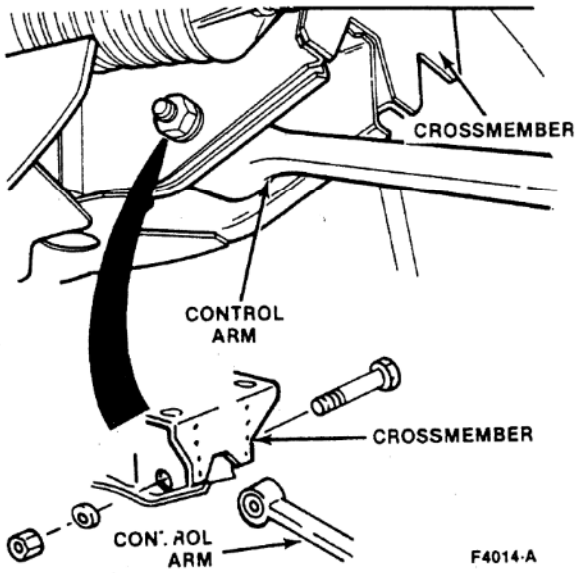
TOP MOUNT INSULATOR

Installation (Continued)

5. Install the cap on the top mount attaching nut.



2. Raise the vehicle.
3. Remove the pivot bolts attaching the control arms to the crossmember.



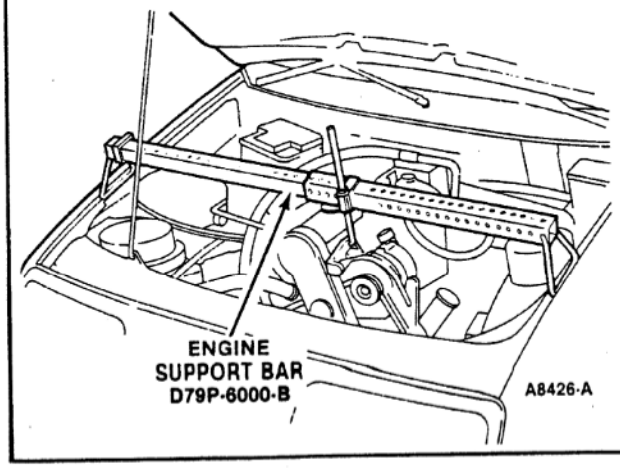
4. To remove the control arm end from the crossmember, grip the bottom of the tire and pull outward.

CROSSMEMBER

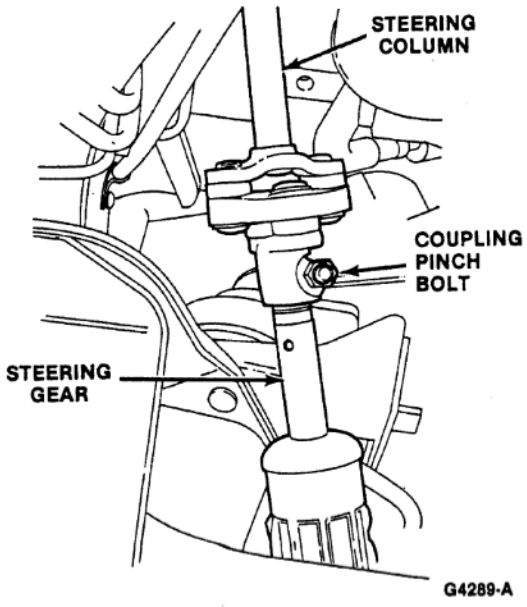
NOTE: The steering must be set straight ahead during the following procedure to ensure that correct alignment is maintained.

Removal

1. Install a suitable engine support fixture.



5. Remove the pinch bolt at the steering column-to-steering gear coupling.

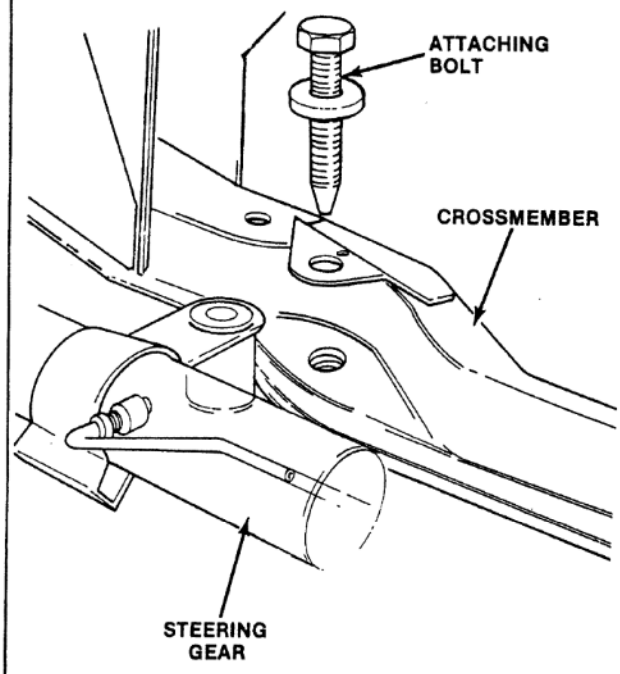


REMOVAL AND INSTALLATION

CROSSMEMBER

Removal (Continued)

6. Remove the steering gear-to-crossmember attaching bolts and washers.

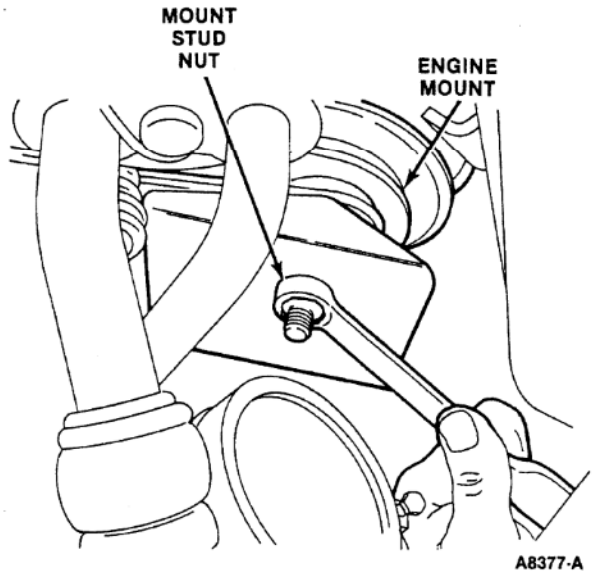


G4291-A

7. Disengage the steering gear coupling from the steering column. Pull steering gear forward away from the crossmember.

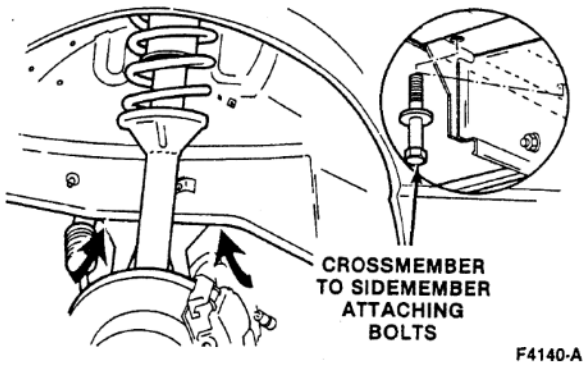
Use care to prevent stretching or bending of the power steering gear hoses or tubes. Support the steering gear by hanging it with wire from a convenient underbody member.

8. Remove the stud nuts attaching the engine mounts to the crossmember.



A8377-A

9. Position a transmission jack under the crossmember and secure with a safety chain.
10. Remove the crossmember-to-side rail attaching bolts and washers.



F4140-A

11. Lower the crossmember and remove from the vehicle.

REMOVAL AND INSTALLATION

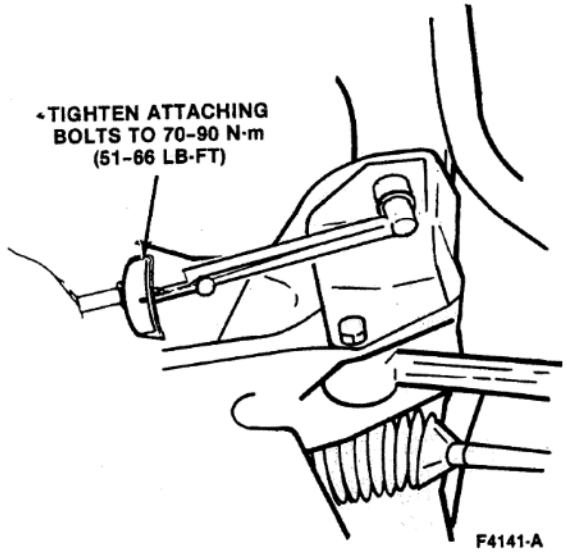
CROSSMEMBER

Installation

1. Raise the crossmember into position.

2. Install the crossmember-to-side rail attaching bolts and washers.

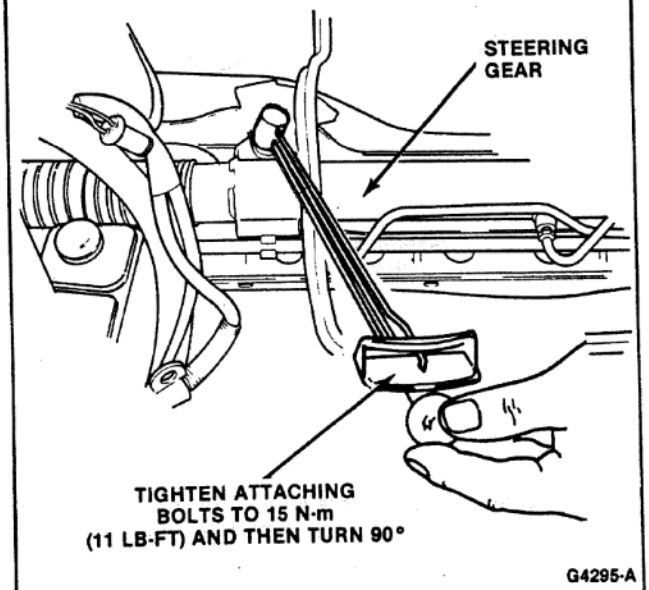
Tighten the attaching bolts to 70 to 90 N·m (51 to 66 lb-ft) and remove the transmission jack.



3. Position the steering gear on the crossmember and connect the coupling to the steering column. Make sure the block splines are correctly mated.

4. Install the steering gear attaching bolts and washer.

Snug the bolts (15 N·m/11 lb-ft) and then turn the bolts an additional ninety degrees.

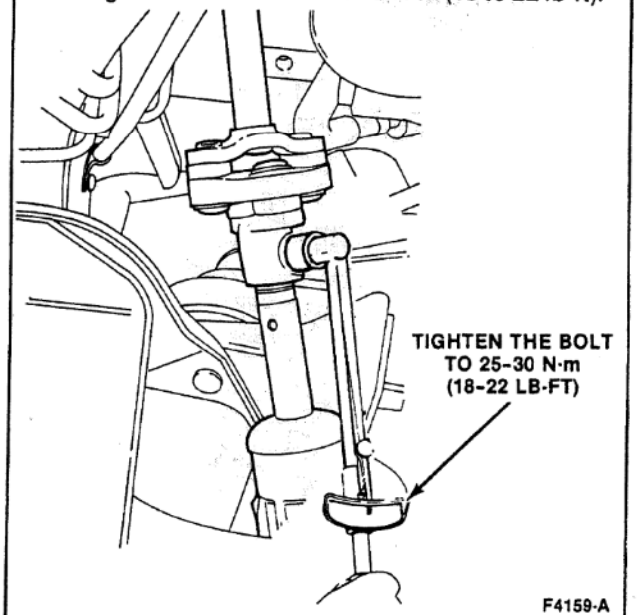


REMOVAL AND INSTALLATION

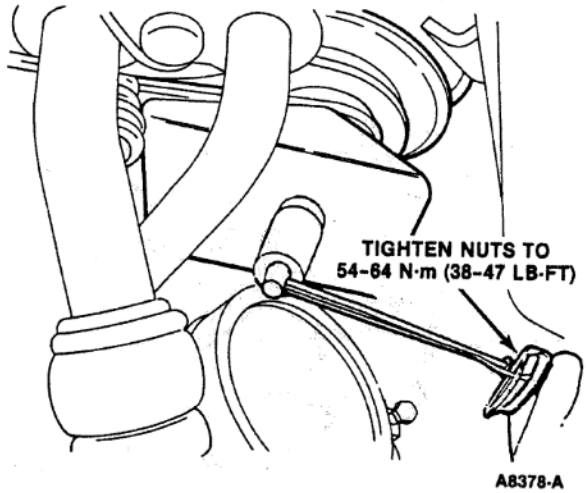
CROSSMEMBER

Installation (Continued)

5. Install the steering coupling pinch bolt.
   Tighten the bolt to 25 to 30 N·m (18 to 22 lb-ft).



6. Install the engine mount attaching nuts.
   Tighten the nuts to 54 to 64 N·m (38 to 47 lb-ft).

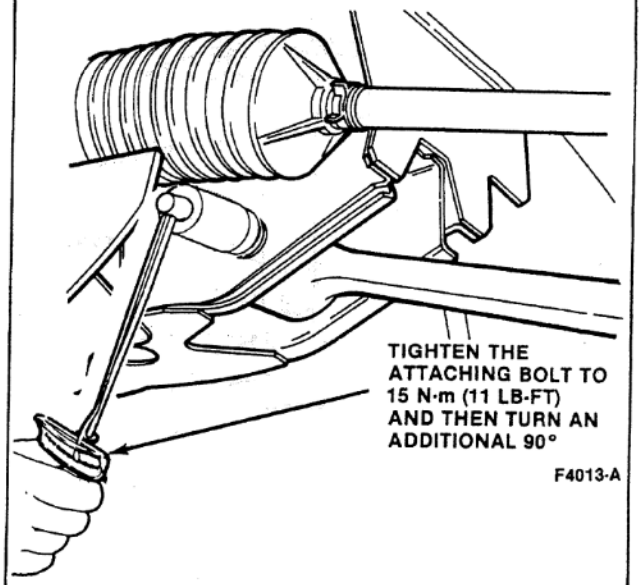


7. Grip the bottom of the tire and pull inward until the control arm enters the crossmember. Align the control arm with the bolt holes and install the pivot bolt.
   Use a drift punch to hold the control arm in alignment while the pivot bolt is installed.
   Repeat this operation on the opposite side of the vehicle.

8. Install the pivot bolt attaching washer and nut.
   Snug the nut but do not tighten.

9. Lower the vehicle.

10. With the weight of the vehicle on the front tires, tighten the control arm pivot bolt nut to 15 N·m (11 lb-ft). Then turn nut an additional ninety degrees.



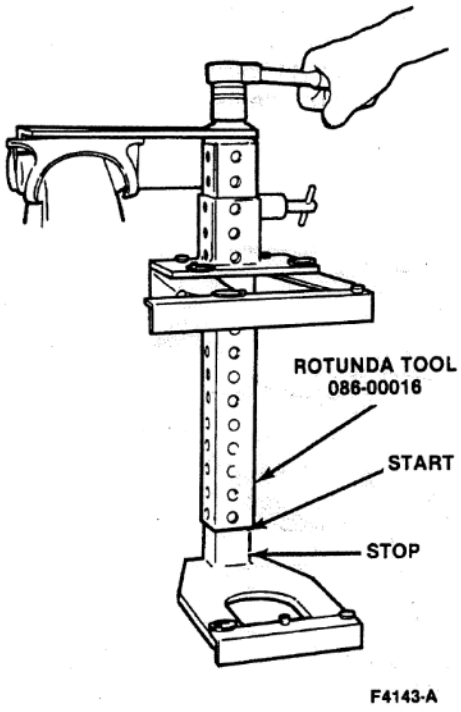
11. Remove the engine support fixture.

DISASSEMBLY AND ASSEMBLY

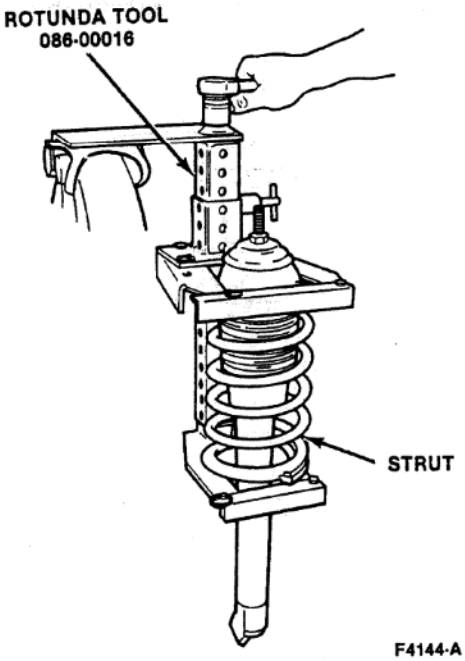
STRUT

Disassembly

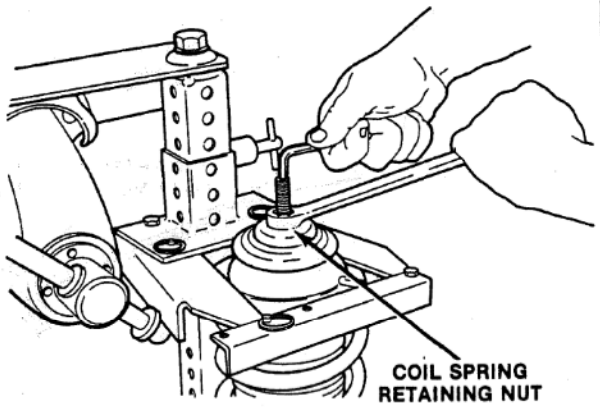
1. Clamp Strut Spring Compressor Rotunda Model 086-00016, or equivalent, in a vise equipped with protective jaw caps. Adjust the tool to the START position. Refer to the instructions furnished with the tool.



2. Carefully compress the coil spring using Strut Spring Compressor Rotunda Model 086-00016, or equivalent.



3. While holding the piston shaft with a 6 mm allen wrench, remove the coil spring retaining nut.



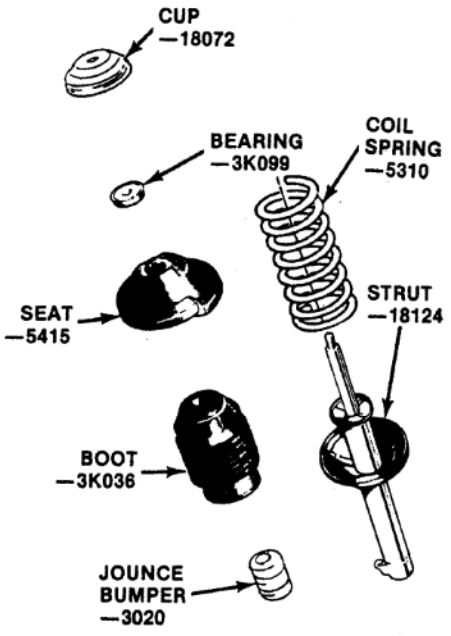
DISASSEMBLY AND ASSEMBLY

STRUT

Disassembly (Continued)

4. Release the coil spring tension.

5. Remove the top mount cup, bearing, upper spring seat, and dust boot.



6. Slide the jounce bumper off the piston shaft.

7. Remove the coil spring.

Assembly

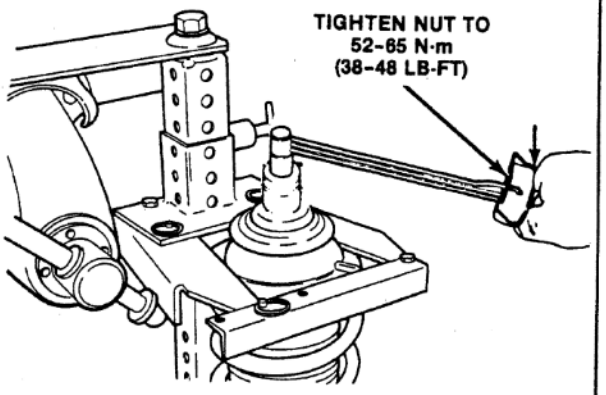
1. Install the coil spring.

2. Install the jounce bumper, dust boot, upper spring seat, bearing and top mount cup.

3. Compress the spring with Strut Spring Compressor Rotunda Model 086-00016, or equivalent.

4. Install the coil spring retaining nut.

   Tighten the retaining nut to 52 to 65 N·m (38 to 48 lb-ft). If necessary, hold the piston shaft with a 6 mm allen wrench.



5. Release the coil spring tension and remove the strut from the spring compressor.

DISASSEMBLY AND ASSEMBLY

COMPONENT INSPECTION CHART
FRONT SUSPENSION

COMPONENT	CHECK FOR
CONTROL ARM	• Worn, loose or damaged bushing • Worn, loose or damaged ball joint (0.5 mm /0.020 in. maximum) — If grease seal is cut or damaged, control arm must be replaced. • Cracks or bent condition
STABILIZER BAR	• Bent or twisted condition • Worn or damaged bushings • Damaged U-brackets • Worn or damaged insulator • Damaged threads on ends of bar
McPHERSON STRUT	• Evidence of fluid leakage • Bent or broken spring seat • Bent or broken pinch bolt hook • Dents in the cylinder
COIL SPRING AND TOP SPRING SEAT	• Collapsed coils • Bent or broken spring seat
TOP MOUNT	• Bent or cracked insulator caps • Cut or torn insulator • Roughness or sticking when the bearing is turned • Damaged bearing
DUST BOOT	• Cuts or tears
CROSSMEMBER	• Cracks • Bent or twisted condition • Elongated or damaged mounting holes

SECTION 14-32 REAR SUSPENSION

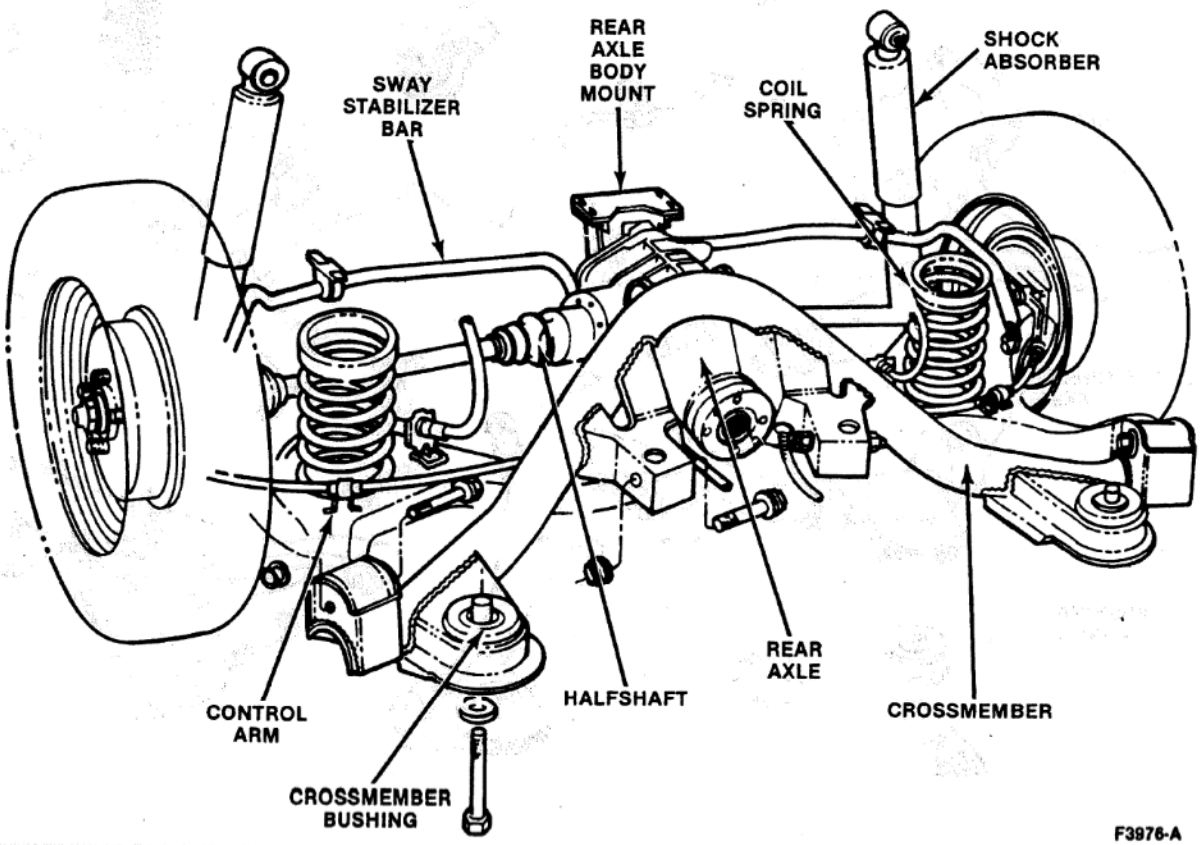
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DESCRIPTION

The XR4Ti's independent rear suspension system consists of semitrailing control arms, double acting shock absorbers, coil springs and a sway stabilizer bar.

Each control arm is attached to the crossmember at two pivot points. The attaching bolts pass through sleeved rubber bushings in the ends of the control arm and serve as pivot pins for the up and down motion of the arms. The coil springs are mounted above the control arm and are seated in matching pockets in the body and the control arm.

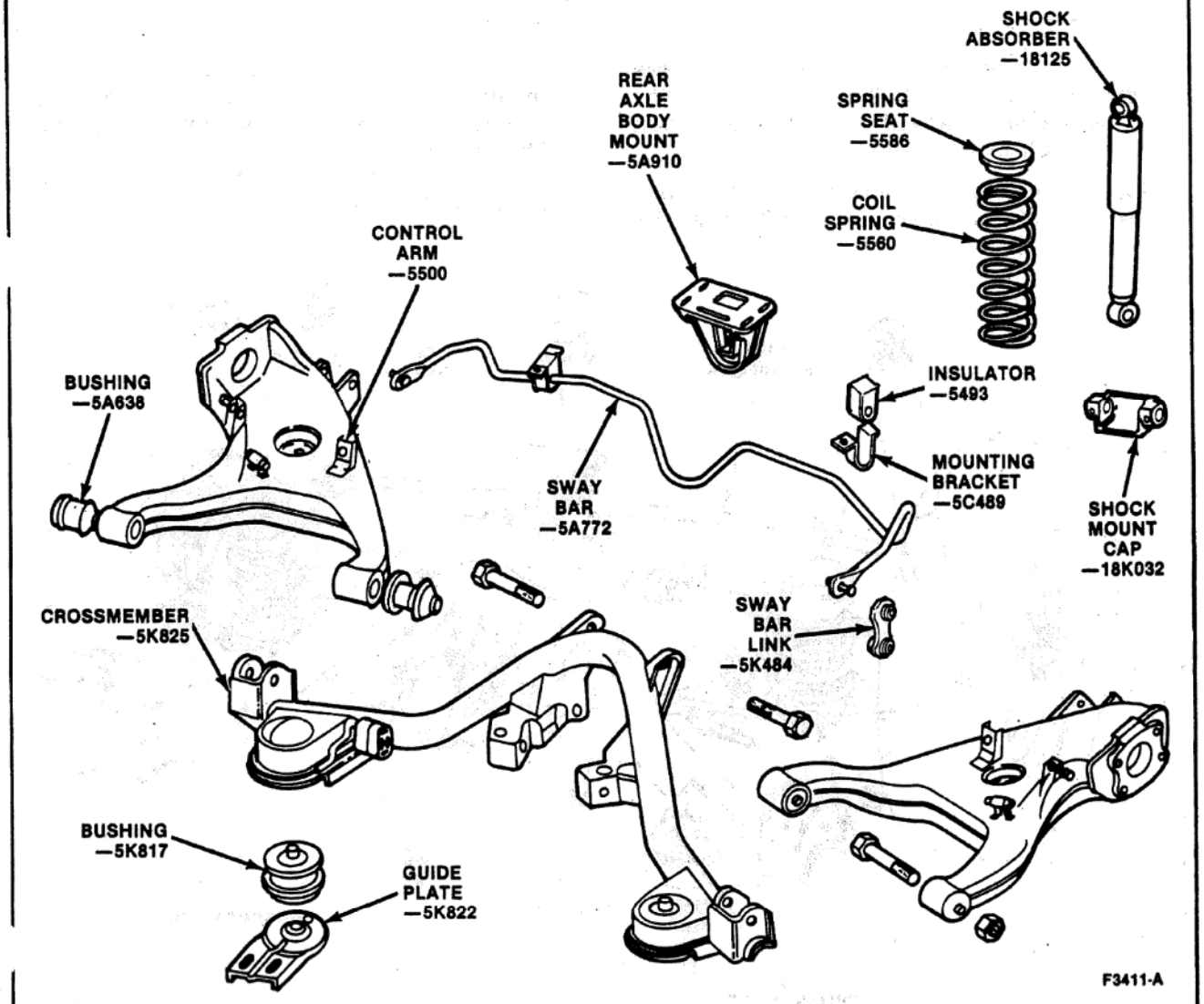


DESCRIPTION

The body pocket contains a rubber insulator to prevent direct contact between the spring coil and the body. A jounce bumper mounted in the center of the coil spring prevents the coil springs from becoming coil bound under severe suspension movements. Normal oscillation of the coil springs is dampened by double acting shock absorbers mounted at the rear of the control arm.

Suspension movement is also controlled by a sway stabilizer bar which controls the tendency of the body to lean during a turn. The stabilizer bar is attached to the body with U-brackets and rubber insulators located on either side of the rear axle. The ends of the stabilizer bar are attached to the control arm with short links containing rubber bushings.

A tubular crossmember forms the framework for the rear suspension components and the rear axle. Rather than being welded to the body, the crossmember is attached through two rubber insulators at the outboard ends and at the center through the rear axle insulator.

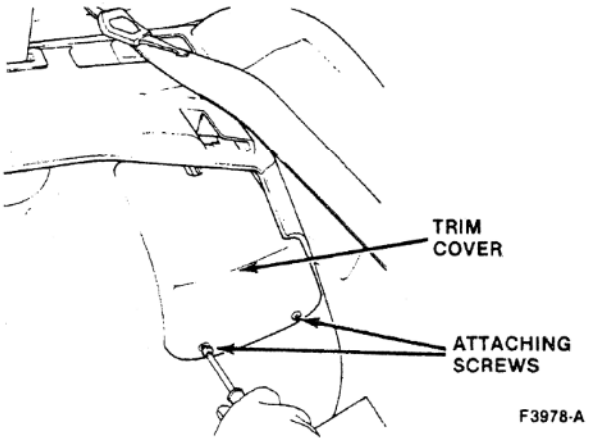


REMOVAL AND INSTALLATION

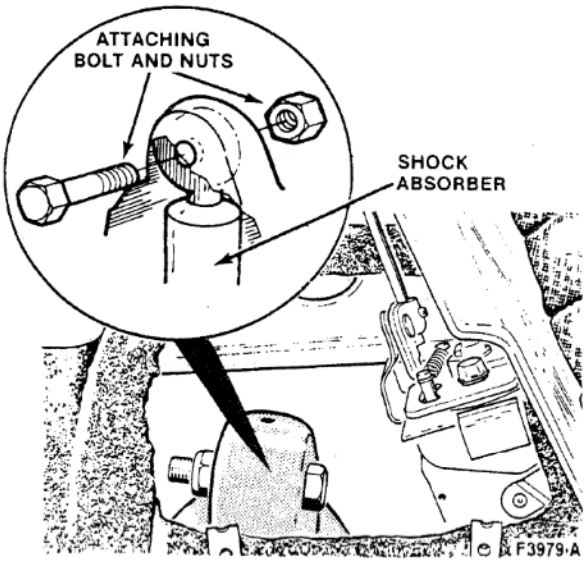
Shock Absorber

Removal

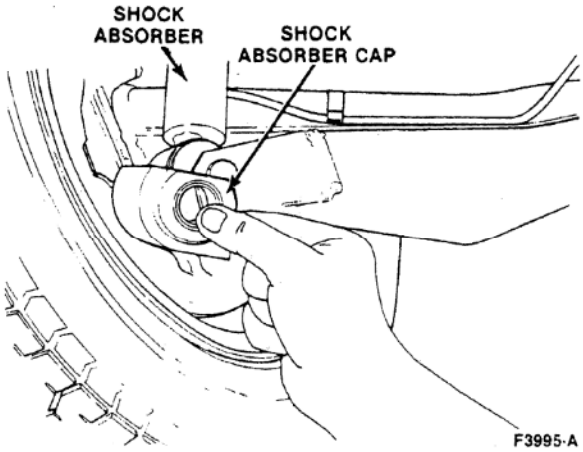
1. Remove the rear parcel shelf.
2. Remove the shock absorber trim cover from the rear wheel housing.



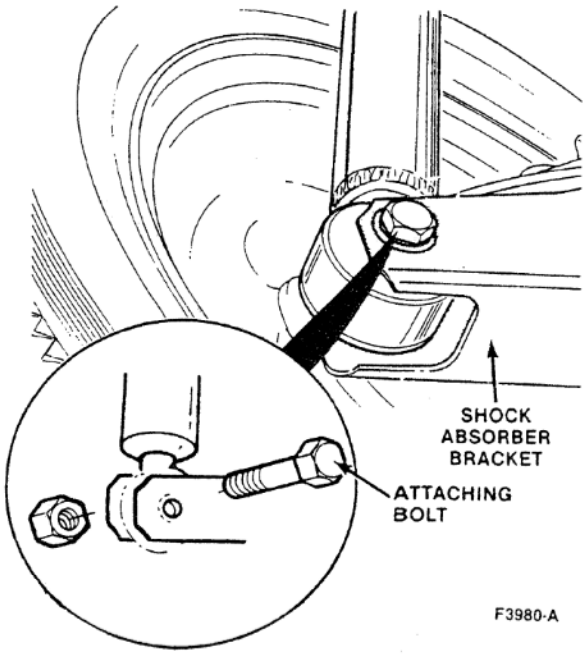
3. Raise the rear of the vehicle and support on safety stands.
4. Position a floor jack under the control arm. Raise it enough to relieve the coil spring tension from the shock absorber.
5. Remove the nut and bolt attaching the upper end of the shock absorber to the shock tower.



6. Remove the cap from the bottom of the shock absorber.



7. Remove the nut and bolt attaching the lower end of the shock absorber to the control arm bracket.

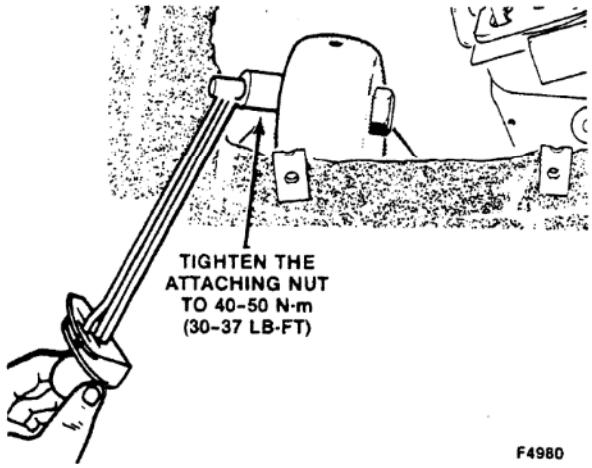


REMOVAL AND INSTALLATION (Continued)

Installation

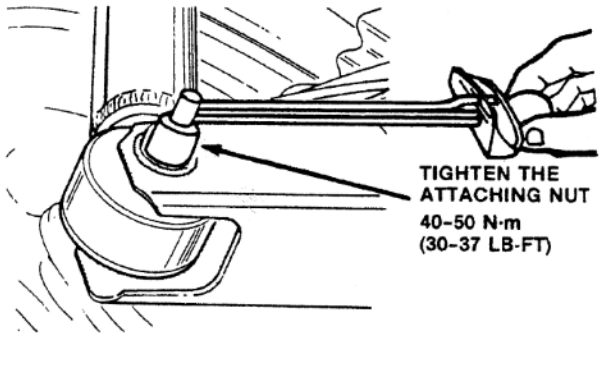
1. Position the shock absorber. Install the upper attaching bolt and nut.

   Tighten the attaching nut to 40 to 50 N·m (30 to 37 lb-ft).



2. Position the shock absorber in the control arm bracket.
3. Install the lower attaching bolt and nut. Install the bolt with the head facing inboard.

   Tighten the attaching nut to 40 to 50 N·m (30 to 37 lb-ft).

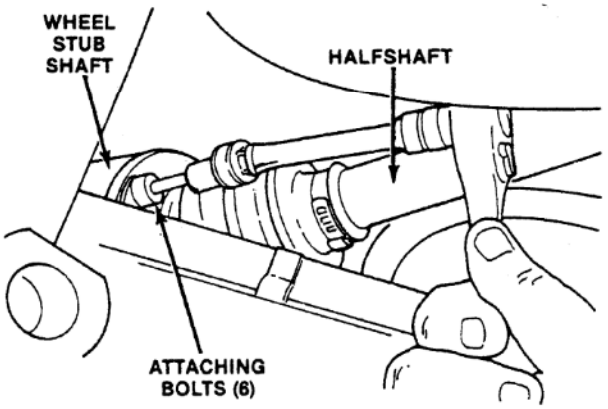


4. Install the cap on the bottom of the shock absorber.
5. Lower the vehicle.
6. Install the shock absorber trim cover.
7. Install the rear parcel shelf.

Coil Spring

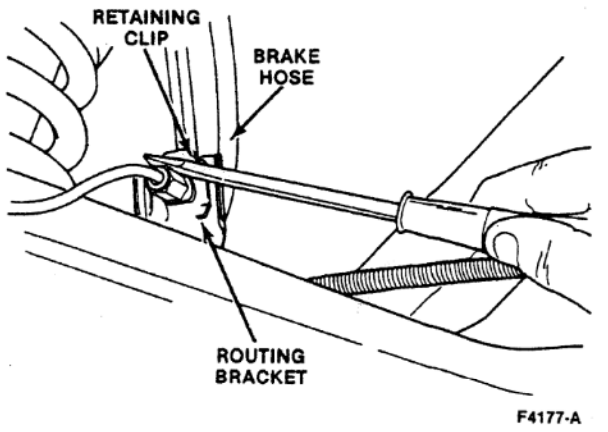
Removal

1. Raise the vehicle with the rear wheels and suspension hanging free.
2. Remove the bolts attaching the halfshaft to the wheel stubshaft.



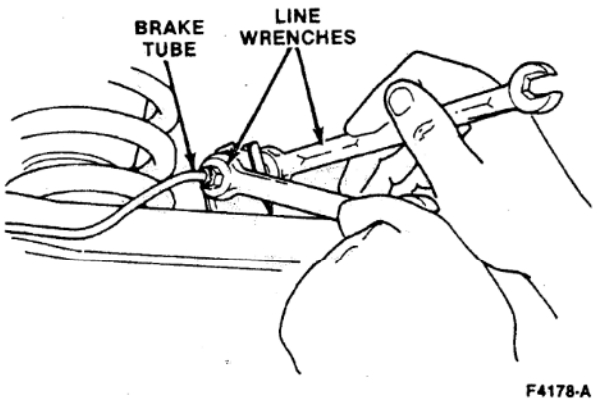
CAUTION: To prevent damage to the constant velocity joints, hang the halfshaft from a convenient underbody component, using a length of wire.

3. Remove the clip attaching the rear brake hose to the routing bracket on the control arm.

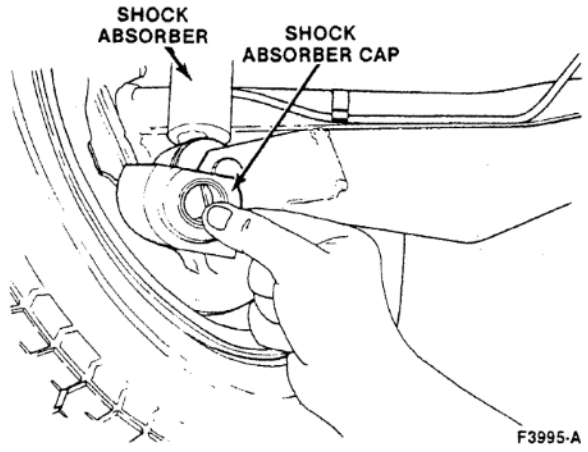


REMOVAL AND INSTALLATION (Continued)

4. Disconnect the brake tube from the brake hose, using line wrenches.

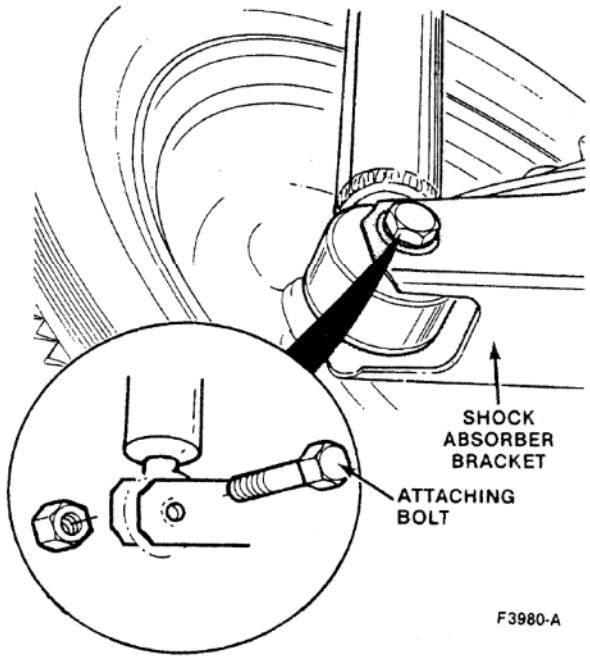


5. Remove the cap from the bottom of the shock absorber.



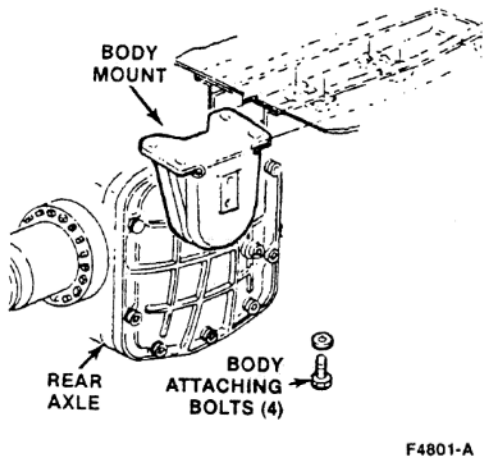
6. Support the lower control arm, using a floor jack or screw-type floor stand. Raise the arm enough to relieve the coil spring tension from the shock absorber.

7. Remove the nut and bolt attaching the shock absorber to the control arm bracket.



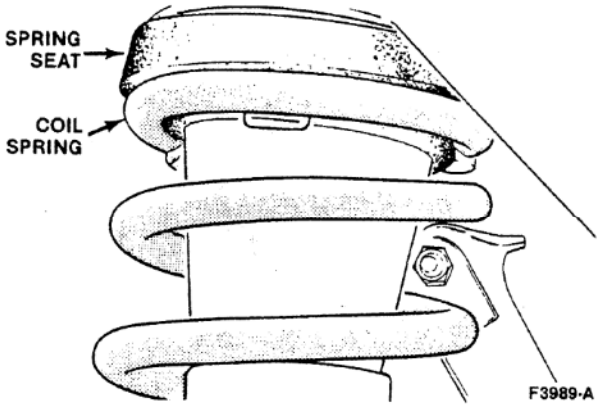
8. Slowly and carefully lower the floor jack or floor stand until it can be removed.
9. Support the axle housing, using a floor jack or screw-type floor stand.

10. Remove the bolts attaching the rear axle mount to the body and disconnect the axle vent tube.



REMOVAL AND INSTALLATION (Continued)

11. Slowly and carefully lower the floor jack or floor stand until the coil spring and seat can be removed.

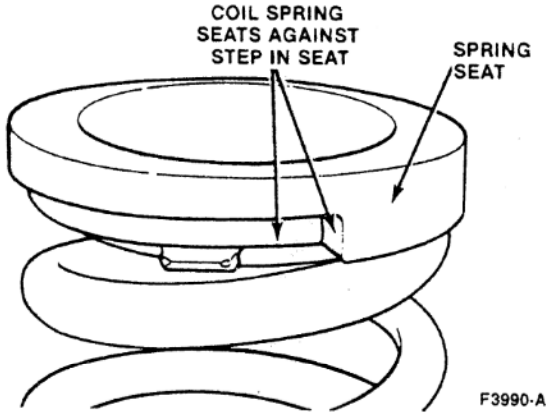


DO NOT remove the support from the rear axle. Lower the axle only enough to allow removal of the coil spring.

Installation

1. Install the spring upper seat on the spring end with the color code and plastic sleeve. Be sure the end of the coil seats against the step in the spring seat and that the seat tabs are positioned between the first and second coil.

NOTE: The coil spring and seat must be installed dry. Do not lubricate with spray silicone or any other type of lubricant.

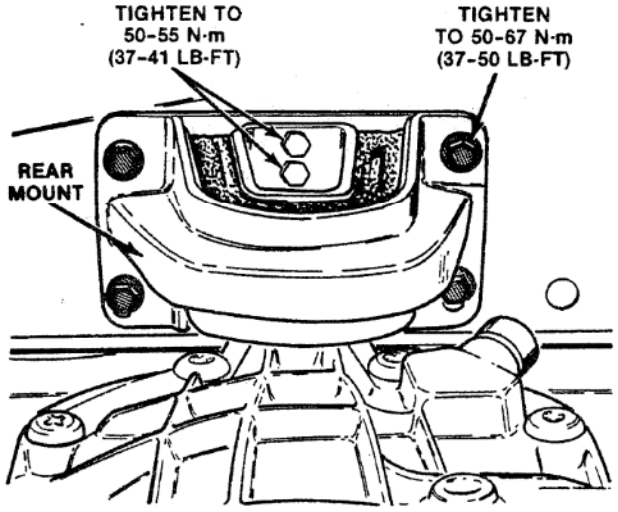


2. Install the coil spring and seat assembly.

3. Raise the rear axle into position and install the body mount attaching bolts.

NOTE: The body mount bolts must be cleaned, and new loctite applied.

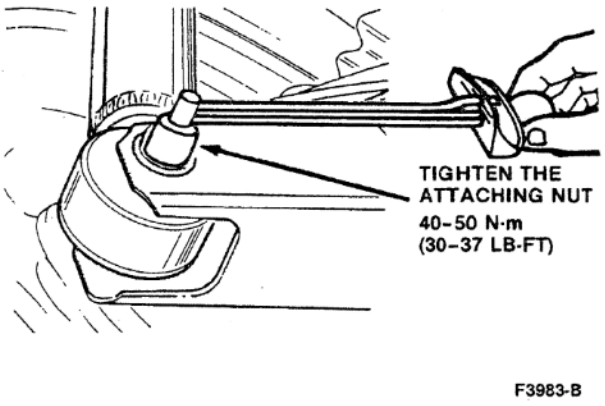
Tighten the attaching bolts as shown.



4. Remove the axle support and position it under the control arm. Raise the floor jack or floor stand until the coil spring is compressed enough to allow installation of the shock absorber lower attaching bolt.

5. Install the attaching nut on the shock absorber bolt.

Tighten the attaching nut to 40 to 50 N·m (30 to 37 lb-ft).



6. Remove the control arm support and install the shock absorber cap.
7. Position the brake hose through the routing bracket on the control arm and connect it to the brake tube.
8. Install the brake hose retaining clip.

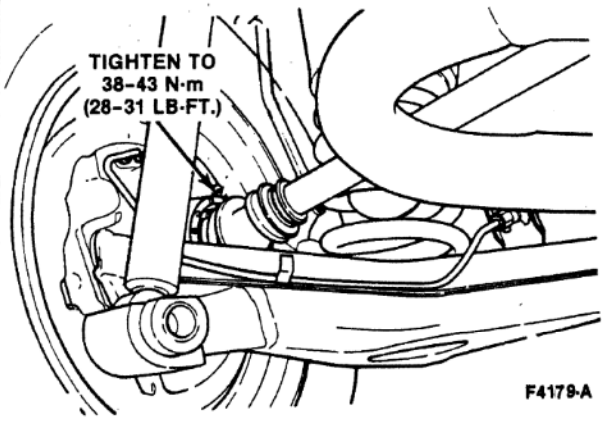
REMOVAL AND INSTALLATION

COIL SPRING

Installation (Continued)

9. Position the halfshaft and install the attaching bolts.

   Tighten the bolts to 38 to 43 N·m (28 to 31 lb-ft).



10. Connect the axle vent hose located at the top right-hand corner of the axle housing.

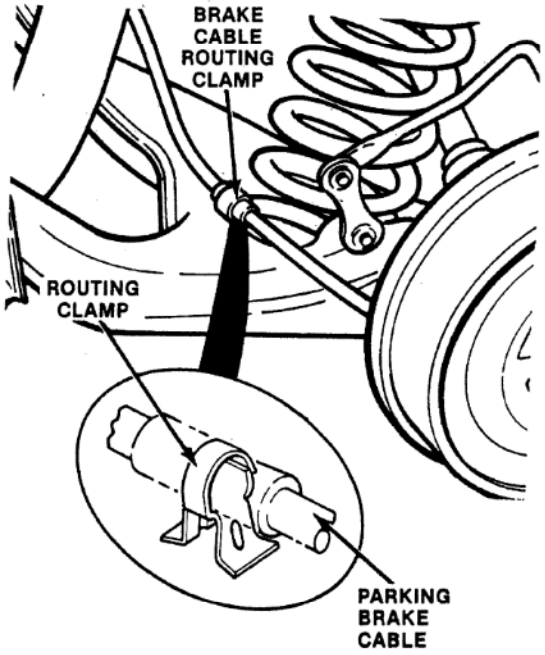
11. Make sure the stabilizer bar link is connected to the control arm.

12. Bleed the rear brake system. If necessary, refer to Section 12-80.

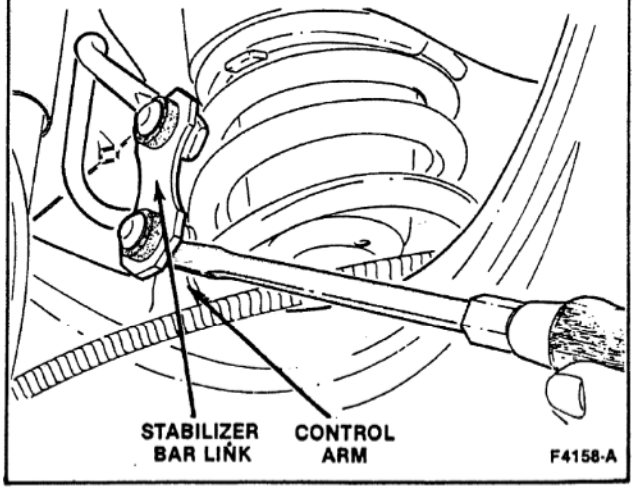
CONTROL ARM

Removal

1. Remove the coil spring. If necessary, refer to the procedure in this section.
2. Using a screwdriver, open the routing clamp and disengage the parking brake cable from the control arm.



3. Disconnect the sway stabilizer link from the control arm.

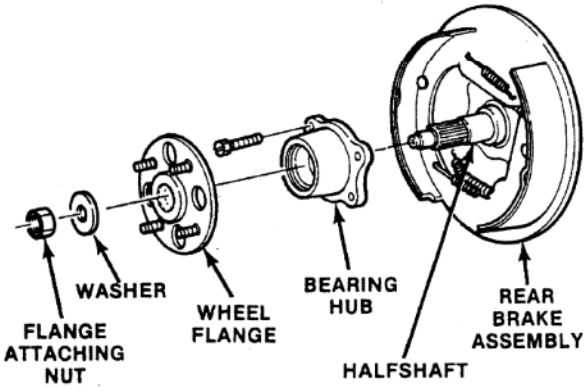


REMOVAL AND INSTALLATION

CONTROL ARM

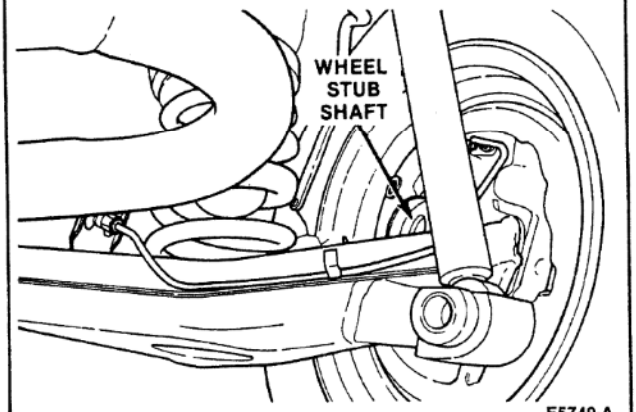
Removal (Continued)

4. Remove the rear bearing hub and suspend the brake backing plate on a length of wire. If necessary, refer to Section 11-15.



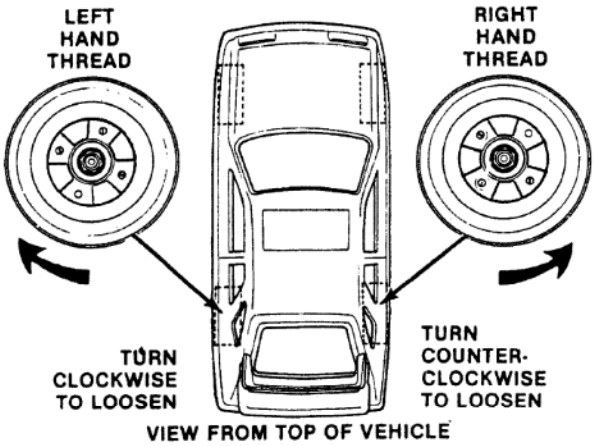
H4434-A

5. From under the vehicle, pull the wheel stub shaft out of the control arm.



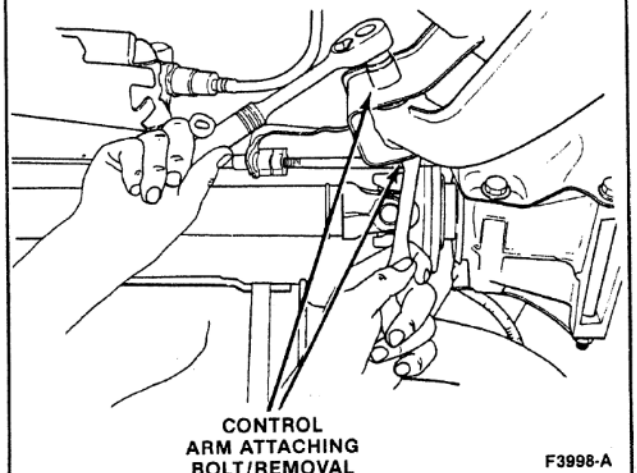
E5749-A

NOTE: The wheel flange attaching nuts are left- and right-hand threaded. The right-hand thread is located on the right side of the vehicle.



E5748-A

6. Remove the control arm inner and outer attaching bolts.



F3998-A

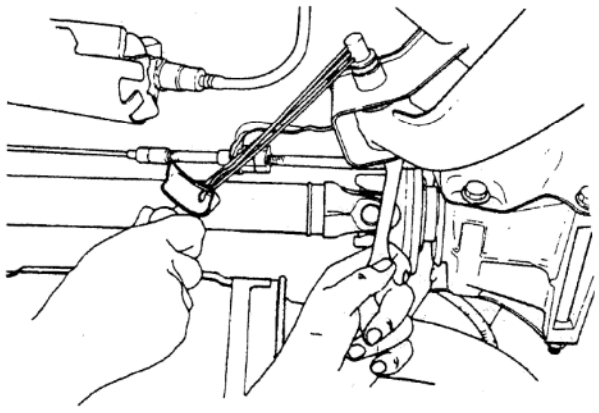
REMOVAL AND INSTALLATION (Continued)

Installation

1. Position the control arm and install the attaching bolts, washers, and nuts. The longer bolts are used on the outboard attachment with the washers. Do not tighten the attaching nuts.

NOTE: When the bolts are installed, be sure the heads are facing inboard. If the bolts are installed with the threads facing inboard, the inner bolt may rub against the parking brake cable casing.

2. Raise the control arm into position and support with a floor jack or adjustable floor stand.
3. From under the vehicle, position the wheel stub shaft through the control arm and brake backing plate.
4. Install the bearing hub and wheel flange. If necessary, refer to Section 11-15.
5. Connect the sway stabilizer bar link to the control arm.
6. Install the parking brake cable in the control arm routing clamp.
7. Install the coil spring. If necessary, refer to the procedures in this Section.
8. With the vehicle weight on the tires, tighten the control arm attaching nuts to 85 to 100 N·m (63 to 74 lb-ft) on the outboard bolts and 70-85 N·m (51-63 lb-ft) on the inboard bolts.



F3999-B

Control Arm Bushings

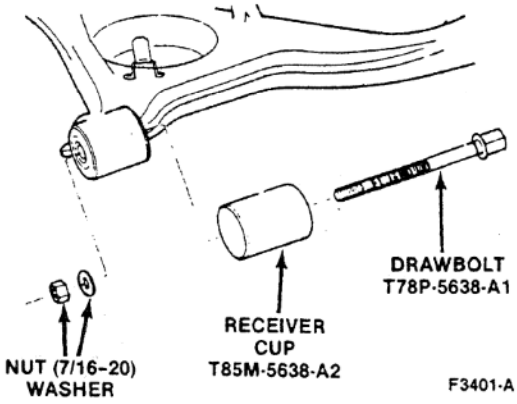
Removal

SPECIAL SERVICE TOOLS REQUIRED:

Drawbolt from Bushing Kit T78P-5638-A	T78P-5638-A1
Bushing Replacer from Bushing Kit T78P-5638-A	T78P-5638-A3
Bushing Receiver Cup	T85M-5638-A1
Bushing Receiver Cup	T85M-5638-A2
Bushing Replacer Cup	T85M-5638-A3
7/16'-20 UNF Hex nut	
7/16' (Bolt Size) Flat washer	

1. Remove the control arm. If necessary, refer to the procedure in this Section.
2. Remove the larger control arm bushing using Drawbolt T78P-5638-A1, Receiver Cup T85M-5638-A2, a 7/16 inch 20 UNF hex nut and a 7/16 inch flat washer, or equivalents.

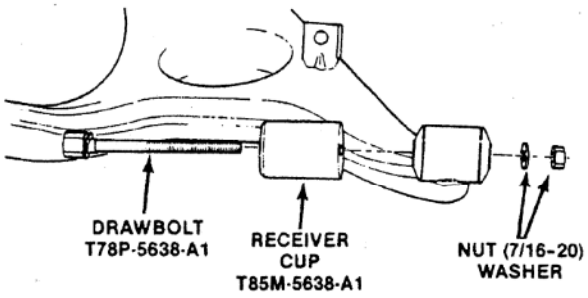
BUSHING REMOVAL



F3401-A

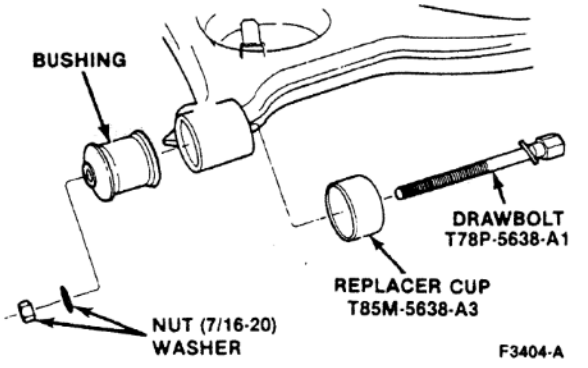
REMOVAL AND INSTALLATION (Continued)

3. Remove the smaller control arm bushing using Drawbolt T78P-5638-A1, Receiver Cup T85M-5638-A1, a 7/16 inch 20 UNF nut and a 7/16 inch flat washer, or equivalents.

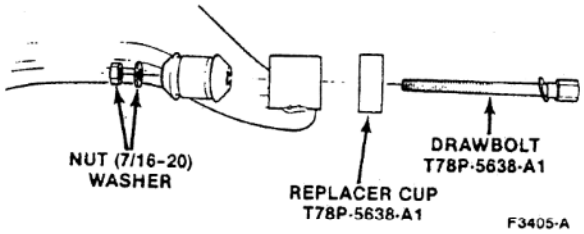


Installation

1. Lubricate the bushings with glycerine or other non-petroleum lubricant.
2. Install a new larger control arm bushing using Drawbolt T78P-5638-A1, Replacer Cup T85M-5638-A3, a 7/16 inch 20 UNF nut and a 7/16 inch flat washer, or equivalents.



3. Install a new smaller control arm bushing using Drawbolt T78P-5638-A1, Replacer Cup T78P-5638-A3, a 7/16 inch 20 UNF nut and a 7/16 inch flat washer, or equivalents.



4. Install the control arm. If necessary, refer to the procedure in this Section.

Rear Crossmember Bushing

Removal

SPECIAL SERVICE TOOLS REQUIRED:

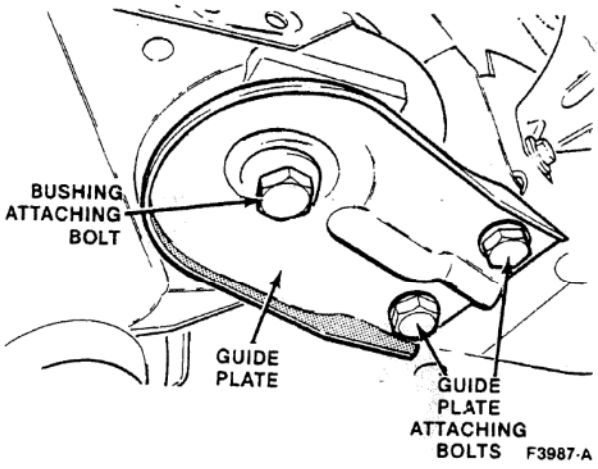
Insulator Remover/Installer	T85M-5638-B
Remover Bridge	T85M-5638-B1
Remover Adapter	T85M-5638-B2
Replacer Bridge	T85M-5638-B3
Replacer Adapter	T85M-5638-B4
Drawbolt	T79P-5638-A1

1. Raise the vehicle with the suspension and tires hanging free.
2. Position an adjustable floor stand under the control arm and raise enough to support the control arm against the downward pressure of the coil spring.

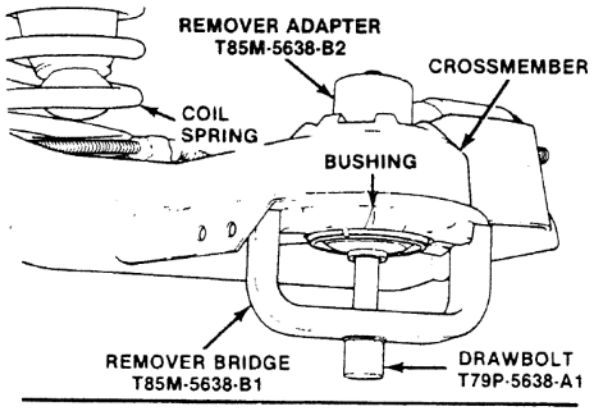
CAUTION: Be sure the control arm is securely supported before removing the bushing to body attaching bolt since the control arm and bushing are under constant coil spring tension. If proper support is not provided, coil spring pressure will drive the crossmember downward when the bushing bolt is removed.

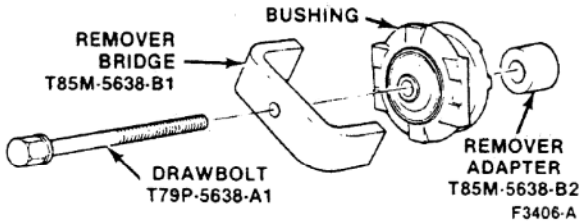
REMOVAL AND INSTALLATION (Continued)

3. Remove the crossmember bushing to body attaching bolt.



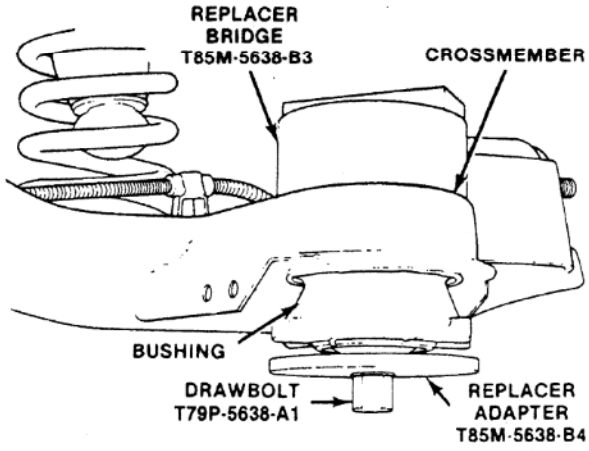
4. Remove the bushing guide plate attaching bolts and the guide plate.
5. Carefully lower the crossmember to provide clearance for the bushing removal and installation tools.
6. Remove the crossmember bushing using Remover Bridge T85M-5638-B1, Remover Adapter T85M-5638-B2, and Drawbolt T79P-5638-A1.

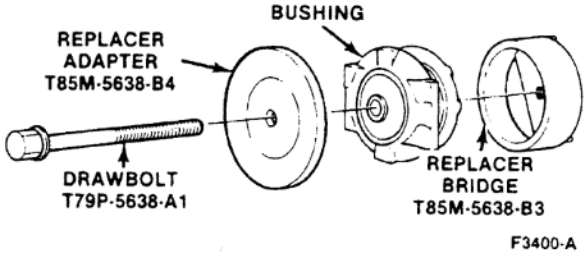




Installation

1. Lubricate the replacement bushing with glycerine or other non-petroleum based lubricant.
2. Install the crossmember bushing using Replacer Bridge T85M-5638-B3, Replacer Adapter T85M-5638-B4 and Drawbolt T79P-5638-A1.

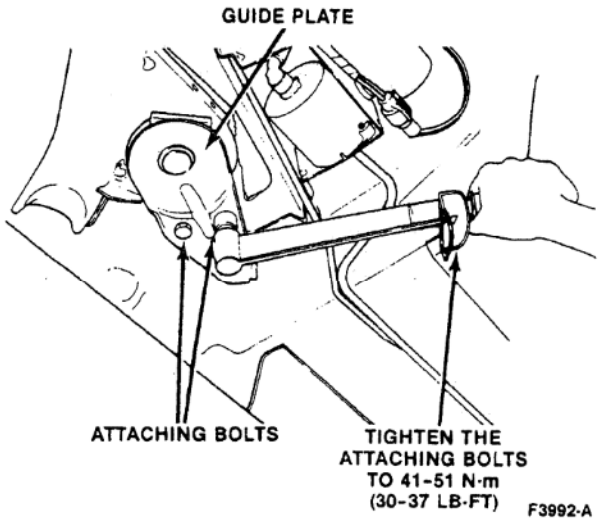




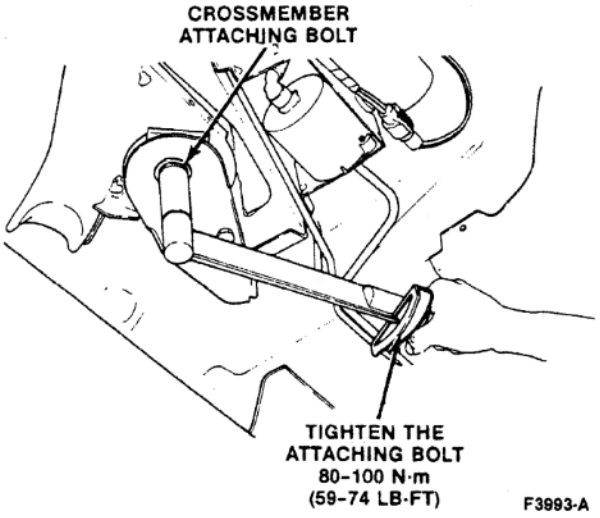
3. Carefully raise the crossmember into position.

REMOVAL AND INSTALLATION (Continued)

4. Position the bushing guide plate and install the attaching bolts. Tighten the attaching bolts 41 to 51 N·m (30 to 37 lb-ft).



5. Install the bushing to body attaching bolt and washer. Tighten the attaching bolt 80 to 100 N·m (59 to 74 lb-ft).



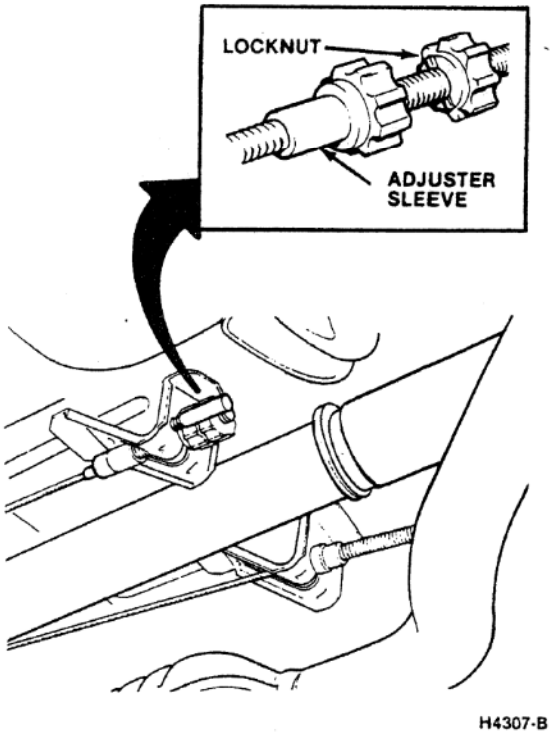
Rear Axle and Suspension Assembly

Removal

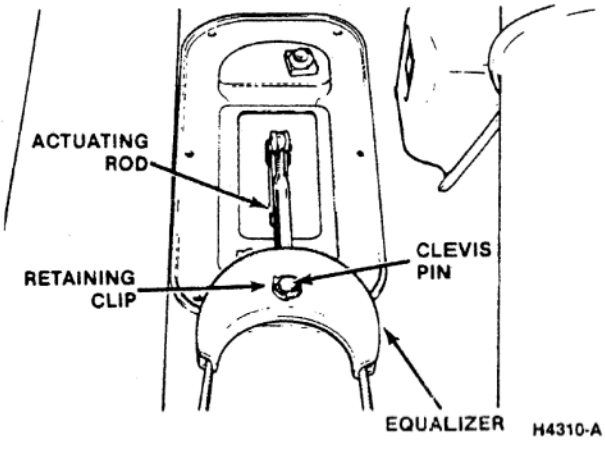
1. Remove the coil springs. If necessary, refer to the procedure in this Section.
2. Remove the driveshaft. If necessary, refer to Section 15-60.
3. Remove the muffler and silencer assembly. If necessary, refer to Section 26-02.

4. Remove locking pin if equipped, and loosen the parking brake adjuster sleeve locknut. Thread the adjuster sleeve away from the body routing bracket.

   To loosen the locknut, hold the cable adjuster sleeve with pliers. Turn the locknut counterclockwise with another set of pliers.

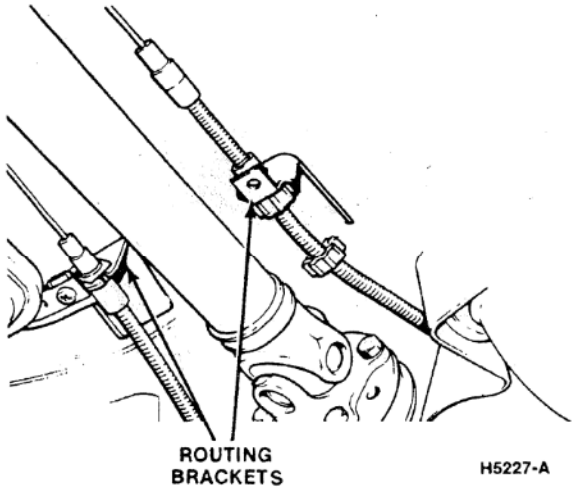


5. Remove the clip and clevis pin attaching the parking brake cable equalizer to the parking brake lever rod.

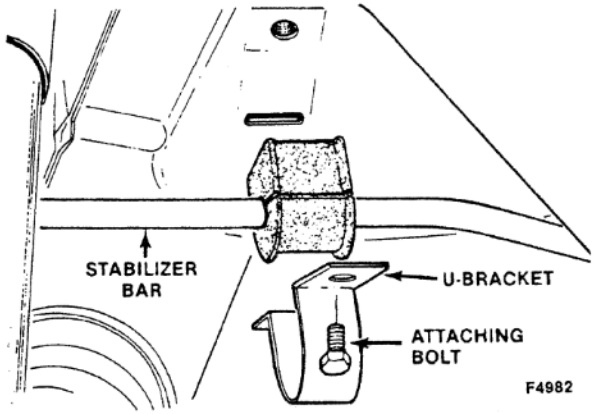


REMOVAL AND INSTALLATION (Continued)

6. Disengage the parking brake cable from the body routing brackets.

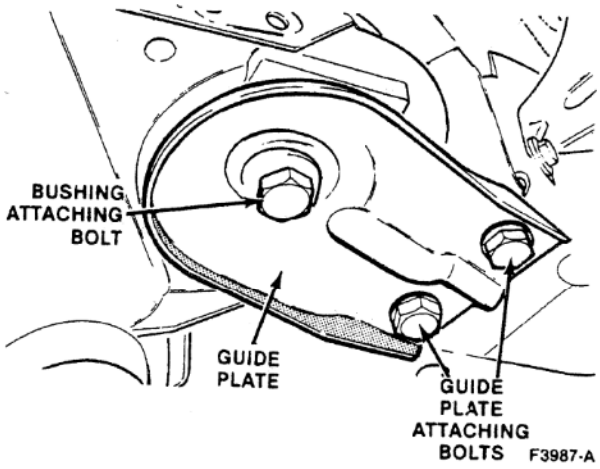


7. Remove the stabilizer bar U-brackets.



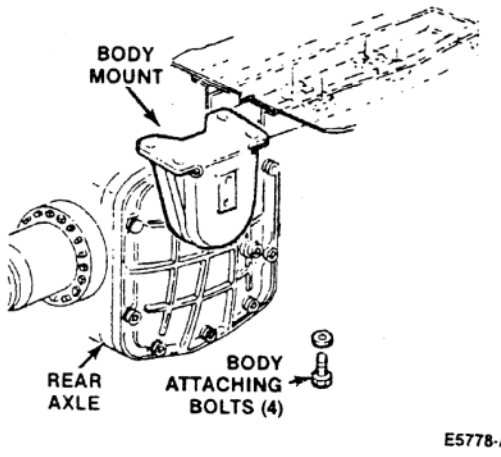
8. Position a suitable jack under the rear axle. Secure the crossmember to the jack with a safety chain.

9. Remove the crossmember bushing attaching bolt on both sides of the vehicle.



10. Remove the crossmember bushing guide plate attaching bolts and the guide plate on both sides of the vehicle.

11. Remove the bolts attaching the axle mount to the body.

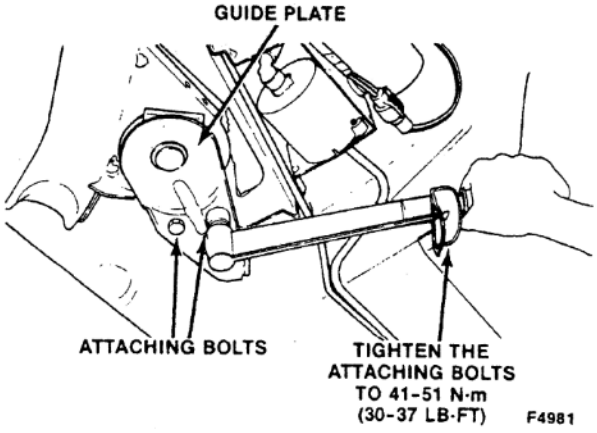


12. Carefully lower the crossmember out of the vehicle.

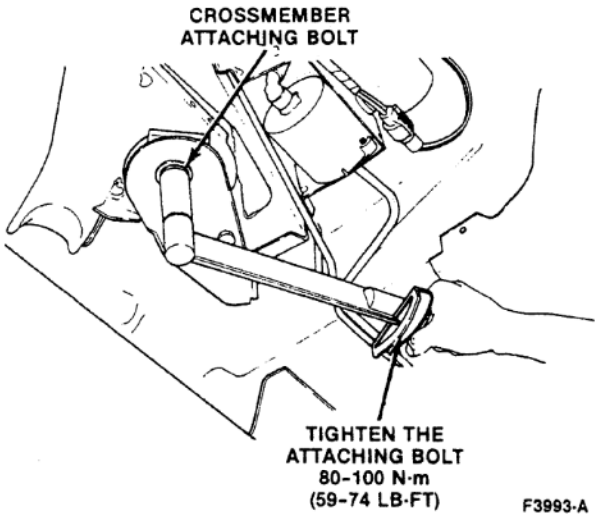
REMOVAL AND INSTALLATION (Continued)

Installation

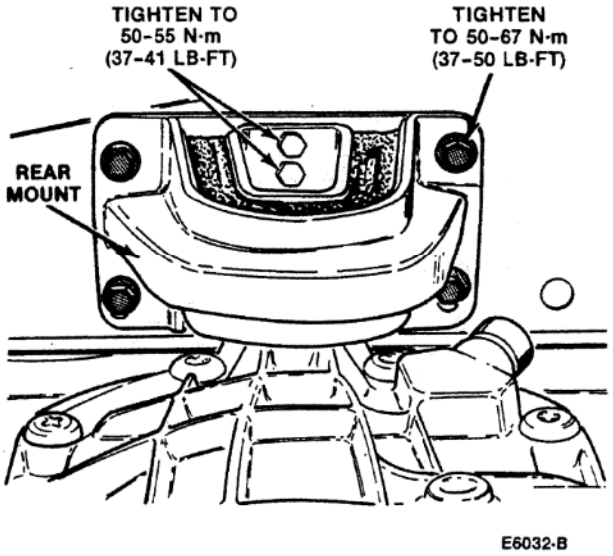
1. Raise the crossmember into position on the vehicle.
2. Install, but do not tighten, the axle mount attaching bolts.
3. Position the crossmember insulator guide plates. Install the attaching bolts.
4. Install the crossmember bushing attaching bolts and washers.
5. Tighten the guide plate attaching bolts to 41 to 51 N·m (30 to 38 lb-ft).



6. Tighten the crossmember bushing attaching bolts to 80 to 100 N·m (59 to 74 lb-ft).

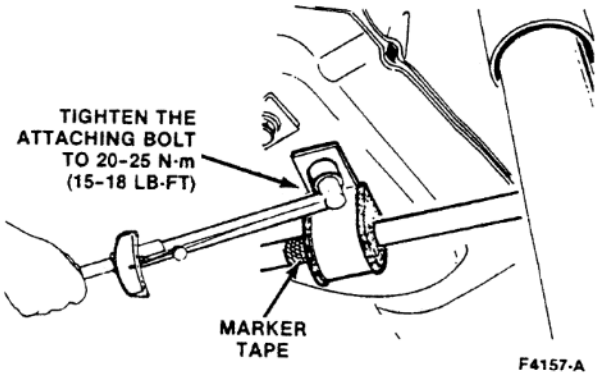


7. Tighten the axle mount attaching bolts as shown.



8. Route the parking brake cable through the body brackets.
9. Position the parking brake equalizer. Install the clevis pin and retaining clip. Adjust parking brake. Refer to Section 12-70 if necessary.

10. Install the stabilizer bar U-brackets. Tighten the attaching bolts to 20 to 25 N·m (15 to 18 lb-ft).



REMOVAL AND INSTALLATION

REAR AXLE AND SUSPENSION ASSEMBLY

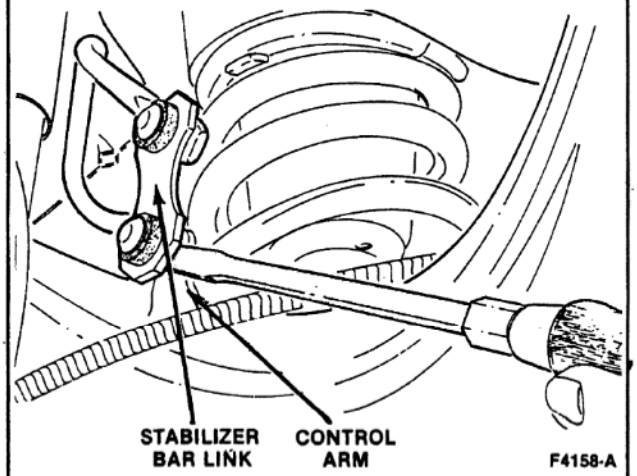
Installation (Continued)

11. Install the muffler and silencer assembly. If necessary, refer to Section 26-02.
12. Install the driveshaft. If necessary, refer to Section 15-60.
13. Install the coil springs. If necessary, refer to the procedure in this section.
14. Bleed the rear brake system. If necessary, refer to Section 12-80.
15. Adjust the parking brakes. If necessary, refer to Section 12-70.

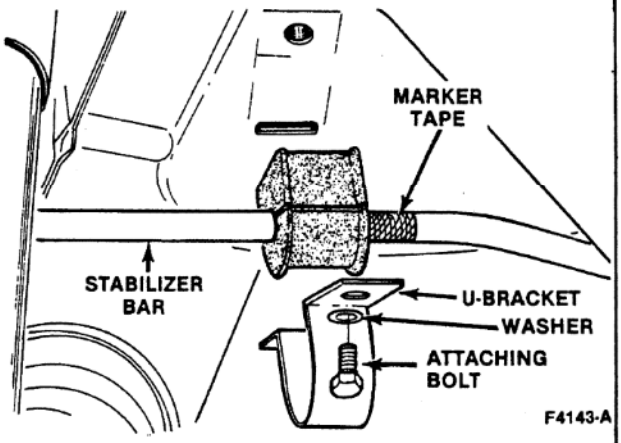
STABILIZER BAR

Removal

1. Loosen the wheel lug nuts. Raise the rear of the vehicle and support on safety stands. Remove the wheels.
2. Disconnect the stabilizer bar links from the lower control arms using a screwdriver.
3. For alignment reference, place a piece of tape on the stabilizer bar next to the U-bracket and insulator.



4. Remove the bolts attaching the U-brackets to the body.

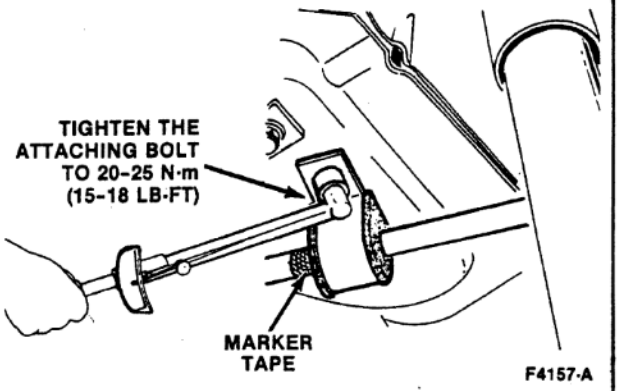


5. Disengage the U-brackets from the body. Remove the stabilizer bar.

Installation

1. Position the stabilizer bar in the vehicle. Engage the U-brackets in the body.
2. Install the bolts attaching the U-brackets to the body.

   Tighten the attaching bolts to 20 to 25 N·m (15 to 18 lb-ft).



3. Connect the stabilizer bar links to the lower control arms.
4. Install the wheels.

Group 14 Specifications

FRONT SUSPENSION: MacPherson Strut

REAR SUSPENSION: Independent with semi-trailing arms and varible rate coil springs

SHOCKS: Direct, double acting, gas pressurized

STRUTS: Direct, double acting, gas pressurized

STABILIZER BAR: Front and rear

TORQUE CHART

ITEM	N·m	lb·ft
FRONT		
Control arm ball joint nut	65-85	48-63
Stabilizer attaching nut	70-110	52-81
Control arm pivot bolt—front	15 + an additional 90°	11 + an additional 90°
Stabilize bar u-bracket bolts (front)	63-70	46-52
Strut pinch bolt	80-90	59-66
Strut top mount nut	40-52	29-38
Crossmember bolts	70-90	51-66
Steering gear bolts	15 + an additional 90°	11 + an additional 90°
Steering coupling pinch bolt	25-30	18-22
Engine mount nuts	54-64	38-47
Coil spring retaining nut	52-65	38-48
REAR		
Shock absorber attaching bolt —lower	40-50	30-37
Control arm pivot bolt—rear		
Inboard	70-85	52-63
Outboard	85-100	63-74
Bushing guide plate bolt	41-51	30-38
Crossmember bushing bolt	80-100	59-74
Stabilizer bar u-bracket bolts (rear)	19- 26	14-19
Shock absorber attaching nut —upper	40-50	30-37

F6276-A

ALIGNMENT SPECIFICATIONS

FRONT

Caster 1°58' ± 1°

Camber –0°32' ± 1°

Toe (acceptable) –0.5mm to 4.5mm (–1/64 to +3/16)
(desired) 2mm ±1mm (5/64 ± 1/32)

REAR

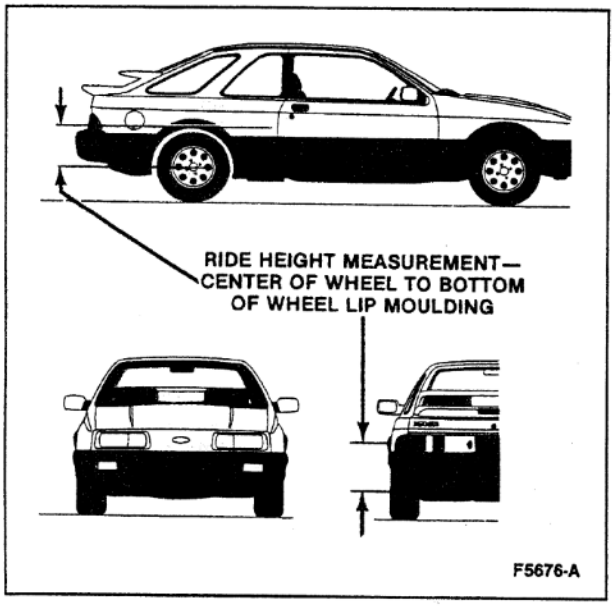
Caster N. A.

Camber (determined by ride height*)

Toe 0.8mm Toe-in ± 3.25mm
(3/64" Toe-in ± 8/64)

Ride Height*	Acceptance Range	Maximum Side-to-Side Variation
350 to 359mm	–2°50' to –0°30'	
360 to 369mm	–2°28' to –0°08'	
370 to 379mm	–2°06' to +0°15'	
380 to 389mm	–1°43' to +0°37'	1°0'
390 to 399mm	–1°21' to +1°00'	
400 to 409mm	–0°58' to +1°22'	
410 to 419mm	–0°36' to +1°45'	
420 to 429mm	–0°13' to +2°07'	

Vehicle ride height is measured from the center of the wheel to the highest point on the wheel opening as shown.



DRIVING AXLES & DRIVESHAFTS

GROUP 15 (4000)

TITLE SECTION	PAGE NO.	TITLE SECTION	PAGE NO.

REAR AXLE DIAGNOSIS 15-01

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PRELIMINARY DIAGNOSIS 2
NOISE DIAGNOSIS 3
LEAKAGE DIAGNOSIS 6
VIBRATION DIAGNOSIS 8
INOPERATIVE CONDITIONS 9

REAR AXLE 15-03

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- Rear Axle Disassembly 5
- Component Inspection Chart 10
- Pinion Bearing Cups 12
- Pinion Inner Bearing 13
- Differential Side Bearing Cups 13
- Axle (Stub) Shaft Seals 13
- Differential Side Bearing Cones 14
- Differential Case 14
- Rear Axle Assembly 16

GENERAL SERVICE PROCEDURES
- Mounting Flange Clearance Check 23

DRIVESHAFT 15-60

DESCRIPTION 1
REMOVAL AND INSTALLATION
- Driveshaft 2

DISASSEMBLY AND ASSEMBLY
- Universal Joints 3
- Support Bearing 3

HALFSHAFTS 15-70

DESCRIPTION
- General Information 1
- Halfshaft Handling 2

REMOVAL AND INSTALLATION
- Halfshaft 2
- Wheel Stub Shaft 3
- Axle Stub Shaft 5

DISASSEMBLY AND ASSEMBLY
- Halfshaft 5

GROUP 15

SPECIFICATIONS 1

SECTION 15-01 REAR AXLE DIAGNOSIS

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	Page		Page
GENERAL INFORMATION	1	LEAKAGE DIAGNOSIS	6
PRELIMINARY DIAGNOSIS	2	VIBRATION DIAGNOSIS	8
NOISE DIAGNOSIS	3	INOPERATIVE CONDITIONS	9

GENERAL INFORMATION

Rear axle problems can be diagnosed and corrected quickly if you know and follow the proper procedure. Being able to perform a good diagnosis is not just a handy tool, but a must if you are going to eliminate guesswork and save time.

This section defines various possible rear axle conditions and tests for identifying the cause and the service procedure. The four rear axle conditions that will be reviewed are:

- Noise conditions
- Leakage conditions
- Vibration conditions
- Inoperative conditions

The diagnostic material also deals with problem analysis; that is, uncovering the original cause of a problem so that you can avoid repeat service. However, the purpose of this section is to provide tips on service steps of special importance.

DIAGNOSIS GUIDE

NOISE CONDITIONS

Bearing Noise
- Half Shaft CV Joint
- Pinion Bearing
- Wheel Bearing

Chatter on Corners
- Differential Thrust Washers

Chuckle Noise
- Differential Gear Clearance
- Damaged Gear Teeth

Clunk Noise
- Stub Shaft Spline Fit
- Stub Shaft C-Clips Missing, Worn or Wrong Fit
- Total Axle Backlash

Gear Howl and Whine
- Check Bearing Preload
- Check Gear Set Backlash
- Incorrect Pinion Depth
- Inspect Gear Set

Knock Noise
- Gear Tooth Damage
- Ring Gear Bolts

NON-AXLE NOISES
- Exhaust
- Grille Whistle
- Tires
- Trim Moulding Whistle

LEAKAGE CONDITIONS
- Axle Cover Sealant
- Stub Shaft Seals
- Axle Vent and/or Hose
- Casting Porosity (Holes in Casting)
- Drive Pinion Nut
- Drive Pinion Seal

VIBRATION CONDITIONS
- Half Shaft Bent
- Drive Pinion Stem and Flange
- Tires
- Universal Joint
- Center Bearing

INOPERATIVE CONDITIONS
- Axle Lock-Up
- Broken Axle Shaft
- Broken Gear Teeth
- Broken Pinion Stem

E5972-A

PRELIMINARY DIAGNOSIS

QUESTION THE CUSTOMER

The preliminary diagnosis begins with the service technician asking the customer enough of the right questions; especially for conditions of noisy operation and/or vibration.

Always ask the customer about:

1. The exact nature of the symptom. If it is a vibration, how is it felt? If a noise, what kind? High-pitched, rumble, loud, etc.?
2. The driving conditions in which the problem appears: road speed, drive or coast, on turns, or on a grade only.
3. Whether the condition is constant or variable; does a noise increase in pitch with speed, etc.?

Obviously, this information should be written concisely but completely on the service order so that the diagnostician (foreman or technician) will know where to start looking. Whoever is doing the diagnosis must be able to identify the axle problem from what is written on the order following the road test.

It is, of course, preferable to have the customer demonstrate the problem on a road test whenever possible.

ROAD TEST

A road test is a must for any complaint of noise and/or vibration that is not eliminated by the on-hoist check of chassis components.

AXLE DIAGNOSIS CHECK SHEET

If there is enough reason to suspect an axle problem, the service technician should also initiate an Axle Diagnosis Check Sheet.

It is most important to record all the information related to the problem to diagnose it accurately and quickly.

The Diagnosis Check Sheet lists four operating conditions or modes in which some axle noises come and go: Drive, Cruise, Coast and Float.

It is important for a good diagnostic check to operate in all four modes and check off those in which the noise occurs. The modes are defined in the chart in case you are not familiar with them. Write down the kilometers-per-hour (miles-per-hour) range at which both noise and vibration occur. On vehicles equipped with overdrive transmissions, it is also important that rear axle noise complaints be evaluated with the transmission in **fourth gear** and not in **overdrive.** Transmission noise can be mistaken for rear axle noise when in overdrive.

AXLE DRIVE MODES

Mode	Conditions
DRIVE	Accelerating the vehicle; a definite throttle depression apply engine torque.
CRUISE	Maintaining a constant speed with the throttle applied.
COAST	Decelerating with the throttle closed.
FLOAT	Controlled deceleration; backing the throttle continually to prevent either braking or accelerating torque from the engine.

E5973-A

NOISE DIAGNOSIS

A gear driven unit, especially an automotive drive axle, will produce a certain amount of noise. Some noise is acceptable and may be audible at certain speeds or under various driving conditions, for example, on a newly-paved blacktop road. The slight noise is in no way detrimental to operation of the rear axle and must be considered normal.

Follow the Diagnosis Charts to isolate rear axle noise.

AXLE NOISE

1. **Gear noise** is the typical "howling" or "whining" of the ring gear and pinion due to an improper gear pattern, gear damage, or improper bearing preload. It can occur at various speeds and driving conditions, or it can be continuous.

2. **Chuckle** is a particular "rattling" noise that sounds like a stick against the spokes of a spinning bicycle wheel. It occurs while decelerating from 64 km/h (40 mph) and usually can be heard all the way to a stop. The frequency varies with the speed of the vehicle.

3. **Knock** is very similar to chuckle, though it may be louder and occurs on acceleration or deceleration. The teardown will disclose what has to be corrected.

4. **Clunk** may be a metallic noise heard when the automatic transmission is engaged in Reverse or Drive, or it may occur when throttle is applied or released. It is caused by backlash somewhere in the driveline or loose suspension components; it is "felt" or heard in the axle.

5. **Bearing whine** is a high-pitched sound similar to a whistle. It is usually caused by malfunctioning pinion bearings, which are operating at driveshaft speed. Bearing noise occurs at all driving speeds; this distinguishes it from gear whine, which usually comes and goes as speed changes.

6. **Bearing rumble** sounds like marbles being tumbled. This condition is usually caused by a malfunctioning wheel bearing. The lower pitch is because the wheel bearing turns at only about 1/3 of driveshaft speed.

7. **Chatter on corners** is a condition where the whole rear end vibrates only when the vehicle is moving. The vibration is plainly felt as well as heard. In conventional axles, extra differential thrust washers cause a condition of partial lockup that creates this chatter.

NON-AXLE NOISE

There are a few other conditions that can sound just like axle noise and have to be considered in pre-diagnosis. The four most common are exhaust, tires, roof racks and trim mouldings.

1. In certain conditions, the pitch of the **exhaust** may sound very much like gear whines. At other times, it can be mistaken for a wheel bearing rumble.
2. **Tires,** especially snow tires, can have a high-pitched tread whine or roar, similar to gear noise. Radial tires, to some degree, have this characteristic. Also, any non-standard tire with an unusual tread construction may emit a roar or whine type noise.

NOISE DIAGNOSIS

NON-AXLE NOISE (Continued)

3. **Trim and mouldings** also can cause whistling or whining noise. Therefore, be sure the trim and mouldings are not the cause of the noise before proceeding with an axle teardown and diagnosis.

REAR AXLE DIAGNOSIS CHART

CONDITION	POSSIBLE SOURCE
• Noise is the same in all modes	• Road noise • Tire noise • Front wheel bearing noise • Pinion Bearings • Wheel Bearings • Axle Shaft Surface Finish
• Noise changes with type of road	• Road noise • Tire noise
• Noise tone lowers as vehicle speed is lowered	• Tire noise
• Noise most pronounced on turns	• Differential side and pinion gears
• Similar noise is produced with vehicle standing and driving	• Engine noise • Transmission noise
• Noise is in one or more modes (Drive, Cruise, Coast, Float)	• Ring and pinion gear
• Clunk on acceleration or deceleration	• Worn differential cross shaft in case
• Vibration	• Refer to Section 18-01

E5974-A

GEAR NOISE—ANALYSIS

Gear Howl and Whine

Before disassembling the axle to diagnose and correct gear noise, it is important that the tires, exhaust, and trim items be checked as possible causes.

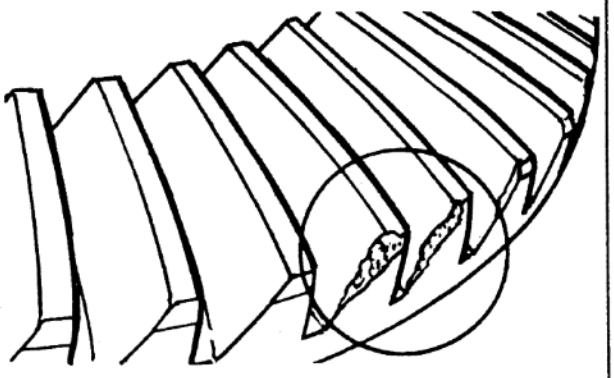
The noises described under Road Test usually have specific causes that can be diagnosed by observation as the unit is disassembled. The initial clues are, of course, the type of noise heard on the road test and the driving conditions.

Chuckle

Chuckle that occurs on the coast driving phase is usually caused by excessive clearance between the differential gear hub and the differential case bore, or by a damaged tooth on the coast side of the pinion or ring gear.

Any damage to a gear tooth on the coast side can cause a noise identical to chuckle. Even a very small tooth nick or ridge on the edge of a tooth is enough to cause the noise.

You can often correct this condition and eliminate the noise simply by cleaning up the gear tooth nick or ridge with a small grinding wheel. If the cleaned-up or damaged area is larger than 3.2 mm (1/8-in), it is advisable to replace the gear set.



DAMAGED GEAR TOOTH E5975-A

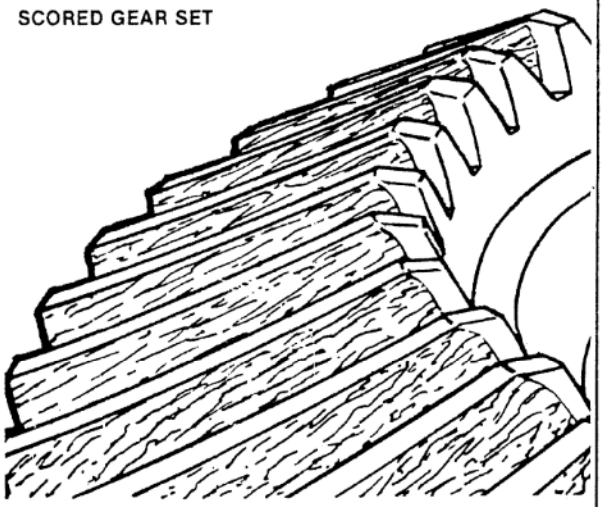
NOISE DIAGNOSIS

GEAR NOISE—ANALYSIS (Continued)

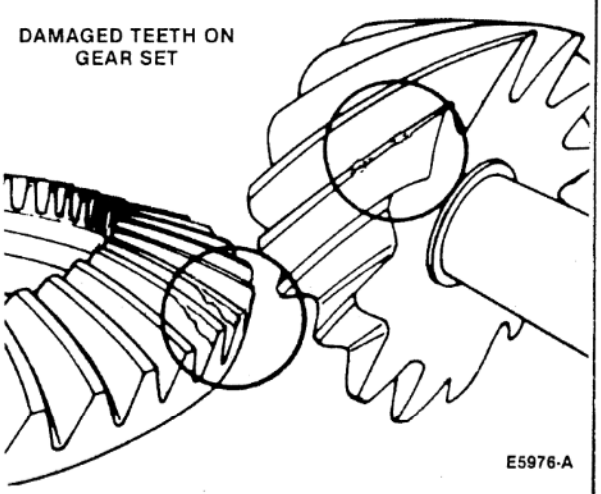
To check the gear set, remove as much lubricant as possible from the gears with clean solvent. Wipe the gears dry or blow them dry with compressed air. Look for scored or damaged teeth. Also look for cracks or other damage.

If either gear is scored or damaged badly, the gear set must be replaced. Also, if there is metal broken loose, the carrier and housing must be cleaned to remove particles that could cause damage later. Any other damaged parts in the axle must be replaced.

SCORED GEAR SET



DAMAGED TEETH ON GEAR SET



E5976-A

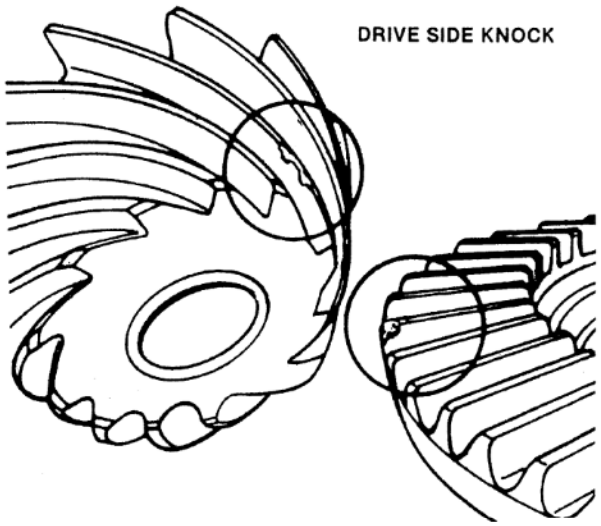
Knock

Knock, which can occur on all driving phases, has several causes. In most cases, you will discover one of the following conditions:

1. A gear tooth damaged on the drive side is a common cause of the knock. This can sometimes be corrected by grinding the damaged area.
2. Occasionally, the ring gear bolts will knock against the inside of the carrier casting. The cause may be too little clearance, due to casting flash or bumps. In this case, the differential case can be removed and the interference points ground out.

   Another possibility is simply that one or more bolts are slightly backed-out. Remove, replace and properly tighten the bolts using Loctite EOAZ-19554-B, or equivalent, on the threads.
3. Knock is also characteristic of excessive endplay in the stub shafts, halfshafts and driveshaft center bearing. The frequency of knock will be less because the halfshaft speed is slower than the driveshaft.

DRIVE SIDE KNOCK



E5977-A

NOISE DIAGNOSIS

GEAR NOISE—ANALYSIS (Continued)

Clunk

Clunk is due to backlash in the driveline, or loose rear suspension components. To determine whether driveline clunk is caused by the axle, make a check of the total axle backlash as follows.

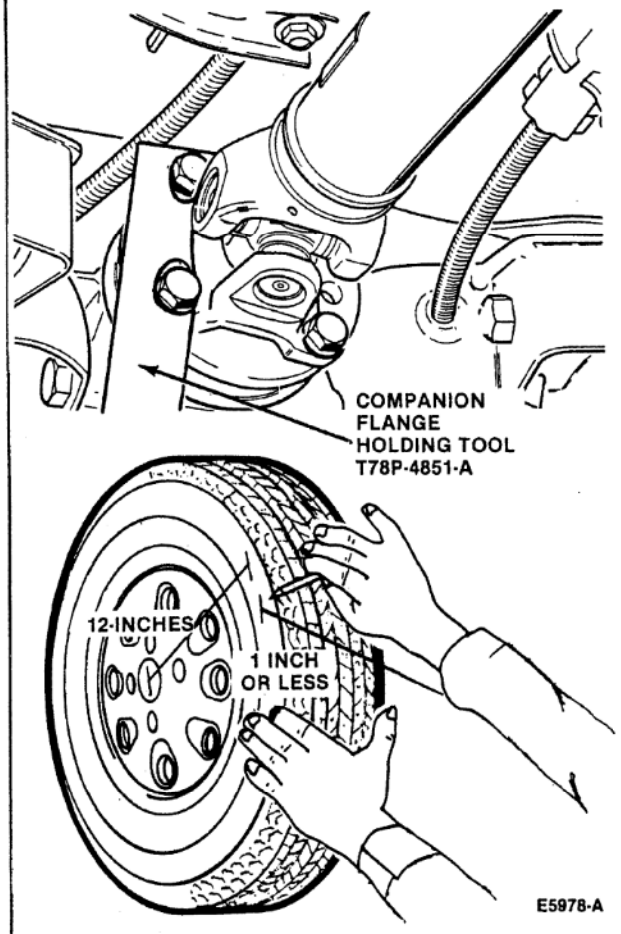
1. Raise the vehicle on a frame or twin post hoist so that the rear wheels are free.
2. Clamp a bar, such as Companion Flange Holding Tool T78P-4851-A, between the axle companion flange and a part of the frame or body so that the flange cannot move.
3. Lock the left rear wheel to keep it from turning.
4. Turn right wheel slowly until you "feel" it in a drive condition. Hold a chalk marker on side of tire 12 inches from center of wheel.
5. Turn the wheel the other way until you again feel the drive condition.
6. Measure the length of the chalk mark; which is the total axle backlash. **Total axle backlash should be one inch or less.**

   If the backlash is within this limit, the clunk will not be eliminated by going into the axle.

Check for these conditions if the backlash is excessive.

1. **Elongation** of the differential pinion shaft holes in the differential case.
2. **Missing** differential or side gear washer.
3. **Galling** of the differential pinion shaft and bore.

   If none of the above conditions show up, there may be a loose fit of the stub shafts to the side gear splines. You should continue as follows **until the correction is made.**
4. Install new side gears and check the backlash again.
5. Install two new stub shafts and C-clips.
6. Replace the differential case.



Bearing Noise

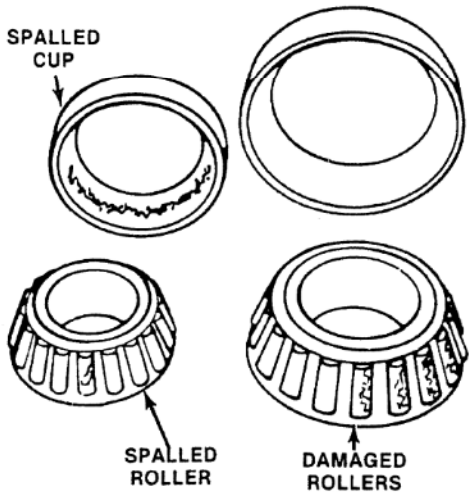
Bearing malfunctions normally will be obvious at disassembly. As noted earlier, pinion bearings make a high-pitched whistling noise, usually at all speeds. However, if there is only one pinion bearing that is malfunctioning, the noise may vary in different driving phases.

Pinion bearings are frequently replaced on axles with low mileage (under 15,000 miles) unnecessarily when correcting gear noise. They should not be replaced unless they are actually scored or damaged, or there is a specific pinion bearing noise. Examine the large end of the rollers for wear. If the bearing's original blend radius has worn to a sharp edge, the bearing should be replaced.

NOISE DIAGNOSIS

GEAR NOISE—ANALYSIS (Continued)

Wheel bearings might be mistaken for pinion bearings, so be sure to look at the wheel bearings carefully before tearing down the axle.



TYPICAL BEARING MALFUNCTION (CAUSING NOISE) E5979-A

Bearing Preload Check

The absence of differential bearing preload causes noise as driving loads tend to move the gear pattern out of position.

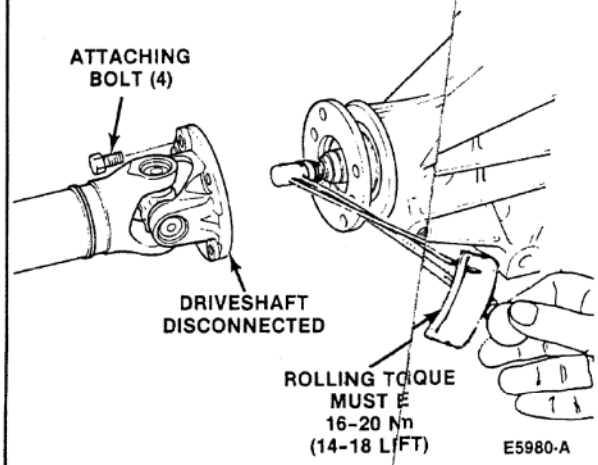
Both the pinion bearing and differential bearing preload must be checked to be sure that the pattern will stay in place under load.

Before checking pinion bearing preload,remove the driveshaft and disconnect the halfshafts from the axle stubshafts. Check the pinion bearing preload by putting a N·m (lb-in) torque wrench on the pinion attaching nut and measuring the torque effort it takes to turn the pinion. Compare the reading with the preload specification at 16-20 N·m (14-15 lb-ft).

NOTE: These preload readings are to be made when the axle assembly is at room temperature or above. Cold lube will give a false reading.

If any endplay or radial play can be detected when applying a force by hand, the pinion bearings are not preloaded.

NOTE: The absence of preload heremay indicate that one or more of the components (i.e. bearings, slinger spacer or flange) is worn or damaged.



E5980-A

LEAKAGE DIAGNOSIS

Most rear axle leakage conditions can be corrected quite simply without a teardown. However, it is important to clean up the leaking area enough to identify the exact source.

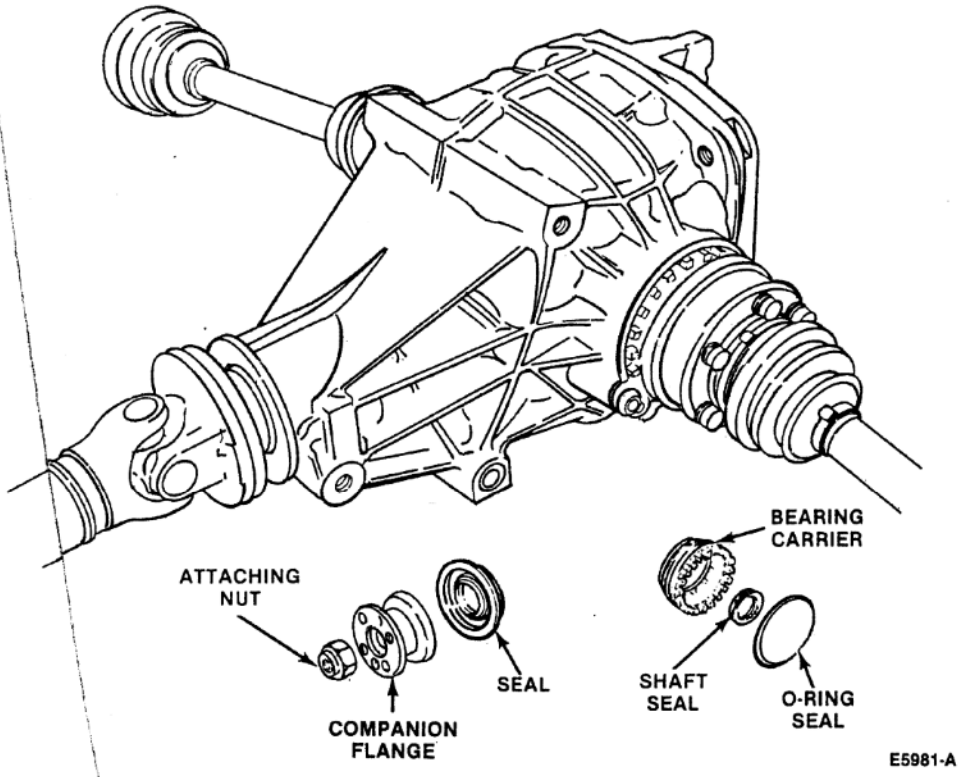
LEAKAGE DIAGNOSIS

DRIVE PINION SEAL

When the drive pinion seal leaks, it is usually because it was not installed carefully or properly, or because of poor quality on the seal journal surface.

Any mutilation of the seal bore, dings, dents, gouges, etc., will distort the seal casing and allow leakage past the outer edge of the seal.

The seal lip can be torn, cut or gouged if it is not assembled carefully. The spring that holds the seal lip against the companion flange may be knocked out and allow leakage past the lip. Marks, nicks, gouges or rough surface texture on the seal journal of the companion flange will also cause leaks. Excessive seal lip wear will be noted. The companion flange should be replaced if any of these conditions exist.



DRIVE PINION NUT

On some high-mileage units, there have been cases of oil leaking past the threads of the drive pinion nut. The condition can be corrected by removing the nut and applying D8AZ-19554-A, or equivalent, sealer on the threads and nut face.

STUB SHAFT SEALS

Stub shaft seals are susceptible to the same kinds of damage as pinion seals if improperly installed. The seal bore must be clean and the lip handled carefully to avoid cutting or tearing it. Stub shaft journal surface must be free of nicks, gouges and rough surface texture.

LEAKAGE DIAGNOSIS (Continued)

Casting Porosity (Holes in Casting)

Occasionally, you will find a differential carrier leaking through small pockets in the metal. These pockets (casting leakage) are caused by gas bubbles in the casting process and are known technically as a porous condition or porosity.

Since there is always the danger of changing the axle's sound characteristics if torn down to replace the carrier, service is preferable. There are two recommended types of service.

1. Peen in a small amount of body lead; then seal the pocket with epoxy sealer Metallic Plastic C6A7-19554-A, or equivalent.
2. In larger pockets, drill a shallow hole and tap it for a small setscrew. Install the setscrew and seal it over with epoxy sealer Metallic Plastic C6A7-19554-A, or equivalent.

Axle Vent

There have been some occurrences of lubricant leaking through the axle vent. This may be caused by overfill, damaged plastic vent assembly or kinked vent tube. If the lube level is correct, check the vent tube for proper installation or replace the vent assembly, using Loctite E0A2-19554-B, or equivalent, to ensure retention.

VIBRATION DIAGNOSIS

Few vibration conditions are caused by the axle. On a vibration problem, follow the diagnosis procedure in Section 18-01, unless a clear reason to suspect the axle is available.

In fact, most vibration problems in the "rear end" are caused by tires or driveline angle.

Tires

Vibration is a definite problem with modern, high-mileage tires, if they are not "true" both radially and laterally. They are more susceptible to vibration around the limits of radial and lateral runout of the tire and wheel assembly. Also, they require more accurate balancing. So wheel and tire runout checks, truing and balancing are normally done before looking at the axle.

Sometimes a vibration problem can be corrected simply by rotating the tires or by proper inflation.

Driveline Angle

An incorrect driveline (pinion) angle can often be detected by the driving condition when vibration occurs.

1. A vibration during coasting from 72 to 56 km/h (45 to 35 mph) is often caused by a high pinion angle.
2. A vibration during acceleration, again around 56 to 72 km/h (35 to 45 mph), may indicate a lower-than-specified pinion angle.

   When it is certain that the tires and driveline angle are not the cause, start looking at the axle and U-joints.
3. A vibration in **all driving phases**, around 56 to 72 km/h (35 to 45 mph), often indicates deterioration of a U-joint or a bent drive pinion stem, which may or may not show up as flange runout.

NOTE: The driveline angle is zero degrees. If a vibration from the driveshaft is suspected make sure the spacer washers are in position under the center bearing support bracket and then refer to Section 18-01 for further diagnosis.

VIBRATION DIAGNOSIS (Continued)

U-Joint Wear

When removing the driveshaft, always check the U-joint for damage.

This sometimes causes a very severe vibration, normally starting between 48 and 56 km/h (30 to 35 mph). It may or may not smooth out as the driveshaft tends to center itself at freeway speeds.

Drive Pinion Stem and Flange

A bent drive pinion stem also can cause vibration as the pinion head or companion flange wobbles off center. This condition, as noted earlier, may or may not show up in a flange runout check.

Flange runout should be checked when all other checks have failed to turn up the cause of vibration.

INOPERATIVE CONDITIONS

In the event the axle simply fails to operate, it does not require much analysis to fix. There will be obviously broken or jammed-up parts. It is important to try to analyze why the parts broke to prevent the condition from recurring.

Broken Half Shaft

Inspect a broken halfshaft for a twist in the spline next to the break.

Breaks that occur away from the spline, or that are not accompanied by a twist in the spline, may be caused by forging flaws and/or fatigue of the shaft.

Conditions that can cause a broken halfshaft include forging flaws or excessive impact load to the shaft as a result of a collision, etc.

Broken Pinion Stem

The drive pinion stem is subject to conditions that can break it anytime the pinion bearing preload is not set up properly. If there is no preload, the front bearing cone and roller will turn relative to the shaft. This galls the roller's shaft and generates heat, which can draw the temper away from the shaft.

Too much preload also generates bearing heat with the same result. The break normally occurs between the two bearings.

Wheel Bearing Malfunctions

Because of the severe loads they must handle, wheel bearings may require replacement at high mileage. If a wheel bearing fails at low mileage, it is often caused by overloading.

Axle Lock-Up

Lock-up or seizure of the axle is usually associated with a low lubricant condition. The lubricant, of course, prevents friction and helps cool the parts as they heat up. Without enough lubricant, the heated parts get soft and may eventually weld together. Check for lubricant leaks after servicing.

SECTION 15-03 REAR AXLE

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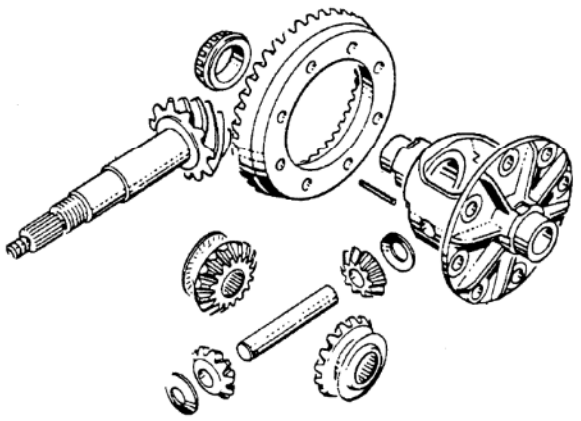
REMOVAL AND INSTALLATION 4

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GENERAL SERVICE PROCEDURES

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E5759-A

DESCRIPTION

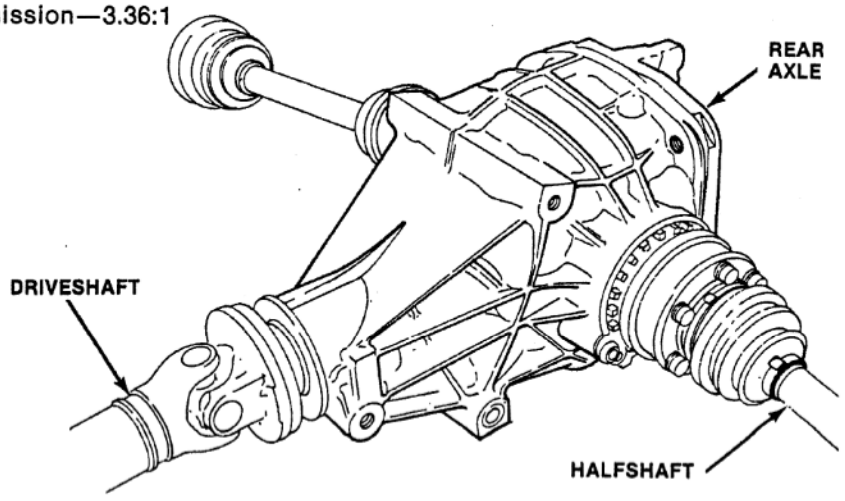
The rear axle contains a 7.5 inch "open" type differential. The axle assembly is mounted on the rear crossmember with additional support provided by a rubber insulated body mount bolted to the axle cover.

The rear axle ratios are as follows:

- Manual transmission—3.64:1
- Automatic transmission—3.36:1

The axle housing is a lightweight aluminum alloy casting.

CAUTION: Special attention should be given during rear axle procedures to ensure no damage occurs to bearing and mating surfaces.



E5760-A

DESCRIPTION

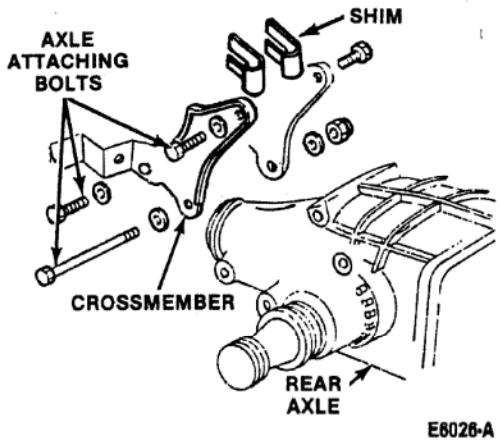
Because the vehicle features independent rear suspension, halfshafts are required to connect the rear axle drive to the rear wheels.

The inner ends of the halfshafts (stub shafts) are splined to the differential side gears and are held in position by selective C-clips located inside the differential case. These selective fit C-clips minimize the possibility of driveline clunk.

Lip seals installed in the differential bearing carriers, prevent oil leakage past the halfshafts. O-ring seals installed on the bearing carriers prevent leakage between the case and the carriers.

The pinion gear shaft and differential case are supported on tapered roller bearings. The pinion bearing cups are pressed into the case. The differential case bearing races are pressed into bearing carriers, which are threaded into the sides of the differential case. Like the case, the bearing carriers are lightweight aluminum castings.

REAR AXLE CROSSMEMBER MOUNTING



E6026-A

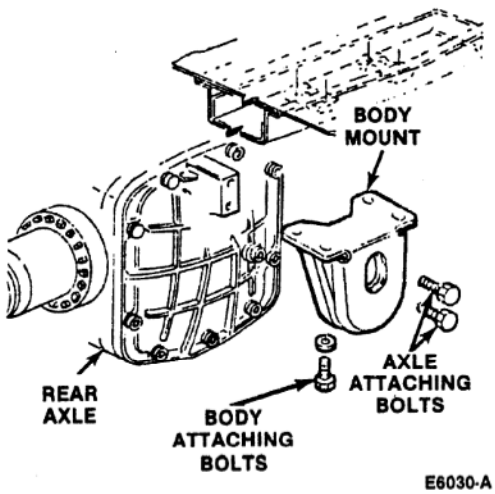
By threading the bearing carriers into or out of the case, ring gear backlash and differential bearing preload can be adjusted. Once the adjustment is made, the carriers are held in position with lock plates and screws.

Pinion bearing preload is maintained by a collapsible spacer positioned between the inner and outer bearings.

The pinion oil seal is replaced without disturbing pinion bearing preload.

During manufacture of the axle, the shim controlling pinion depth is installed under the inner pinion bearing cup. For service, the manufacturing shim is replaced with a standard 2 mm shim. A second shim, for controlling pinion depth, is then installed between the head of the pinion and the pinion inner bearing.

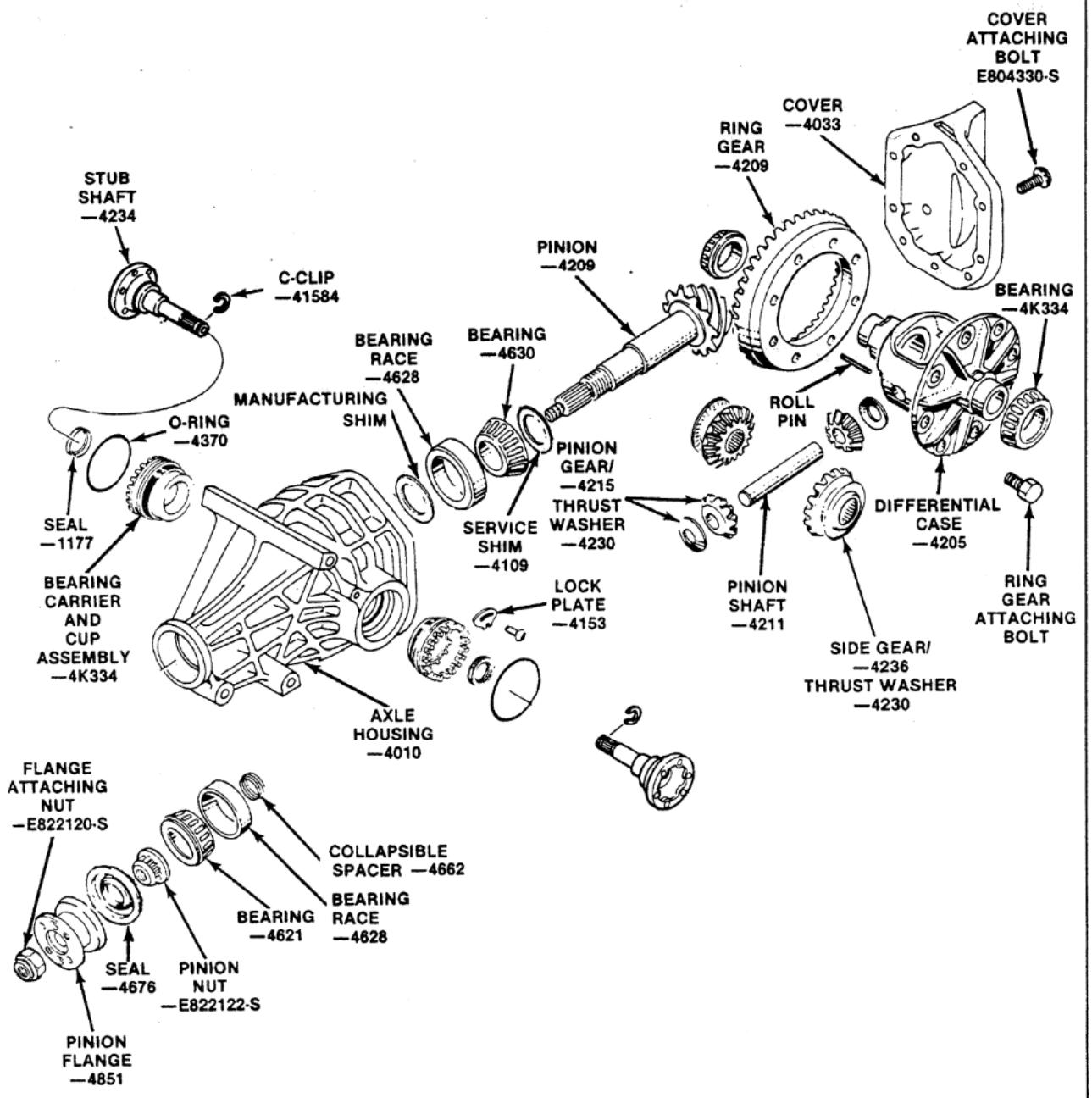
REAR AXLE BODY MOUNT



E6030-A

DESCRIPTION (Continued)

Rear Axle Disassembled View

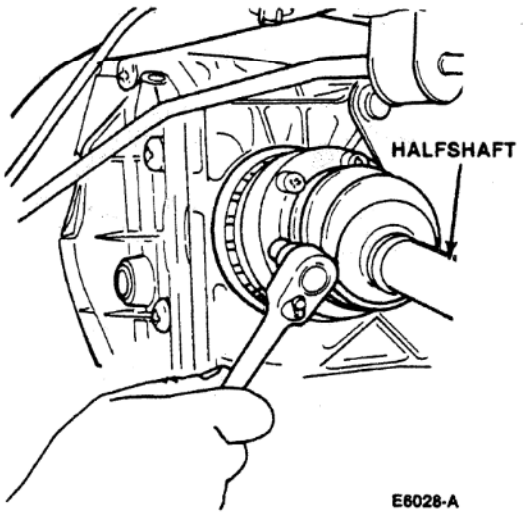


REMOVAL AND INSTALLATION

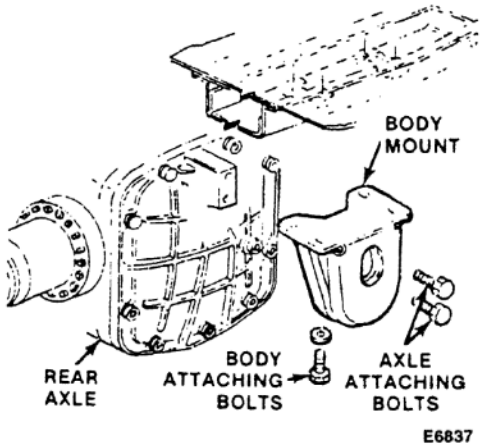
Rear Axle

Removal

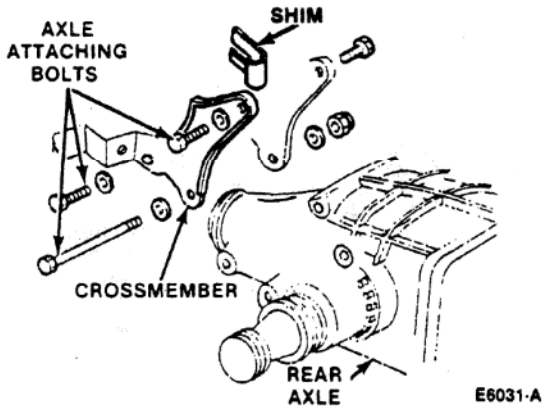
1. Disconnect the axle halfshafts from the stub shaft flanges on each side of the housing. Six socket-head cap screws are used at each flange. Before releasing the halfshafts, support them from the body floor in approximately their normal positions, to avoid excessive CV joint angularity.



2. Remove the driveshaft. If necessary, refer to Section 15-60.
3. Support the rear axle housing with a jack and remove the rear body mount attaching bolts.



4. Remove the four bolts and two shims (if equipped) attaching the front end of the axle housing to the crossmember brackets. Remove the nut and through-bolt attaching the axle housing to the crossmember.



5. Lower the axle housing clear of the rear suspension and remove it.
6. Remove the rear mount, attached to the axle cover by two bolts.

Installation

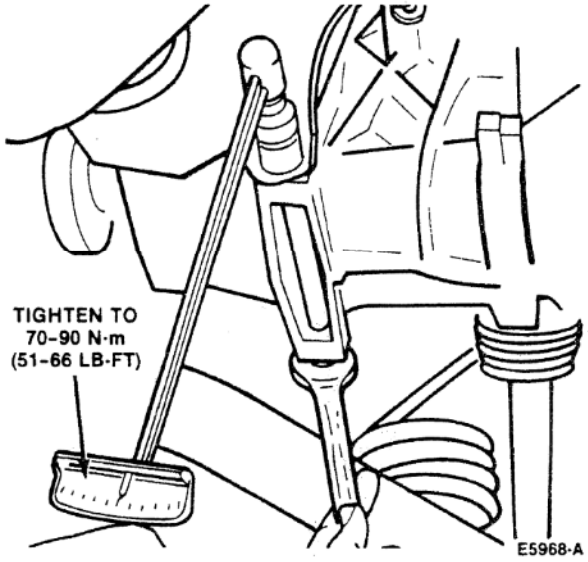
CAUTION: If any of the following items have been replaced, refer to the flange clearance check at the end of this section.

- Axle case
- Axle assembly
- Suspension crossmember

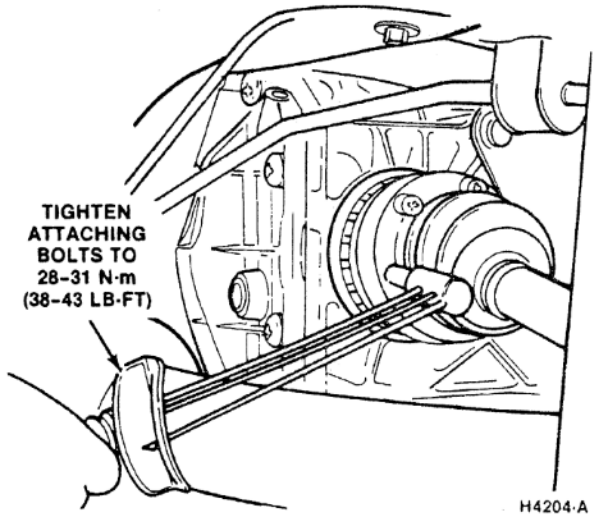
1. Install the rear mount on the axle housing rear cover. Tighten the attaching bolts to 50 to 55 (37 to 41 lb-ft).
2. Lift the assembly into position between the crossmember flanges.
3. Install the through-bolt, axle-to-crossmember attaching bolts and shims (if equipped).
4. Position the axle housing rear mount against the body and secure with four bolts. Tighten the attaching bolts to 50-67 N·m (37-50 lb-ft).

REMOVAL AND INSTALLATION (Continued)

5. Tighten the through-bolt and axle-to-crossmember attaching bolts to 70-90 N·m (51-66 lb-ft).



6. Install the driveshaft. If necessary, refer to Section 15-60.
7. Connect the axle halfshafts to the stub shaft flanges and install the attaching bolts. Tighten the attaching bolts to 28-31 N·m (38-43 lb-ft).



DISASSEMBLY AND ASSEMBLY

Disassembly

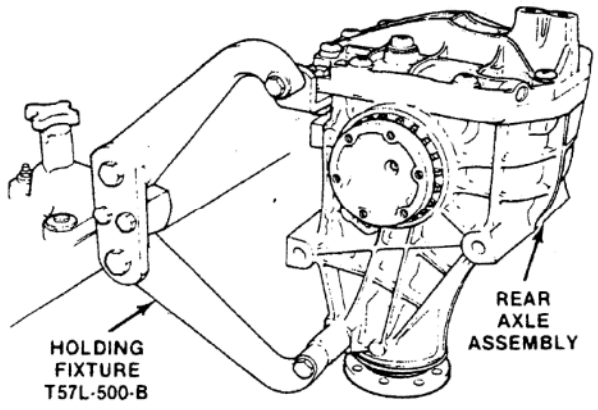
SPECIAL SERVICE TOOLS REQUIRED:

T57L-500-B	Holding Fixture
D78P-1225-B	Bearing Cup Puller
T85M-4970-A	Side Bearing Adjusting Wrench
T78P-4851-A	Companion Flange Holding Tool
D80L-1002-L	Puller
T85M-4610-A	Pinion Nut Socket
T85M-4610-B	Pinion Spline Socket
T85M-4616-A	Pinion Bearing Cup Replacer
T56T-4616-B2	Pinion Bearing Cup Replacer
T75T-1176-A	Threaded Drawbar
T71P-4621-B	Pinion Bearing Cone Remover
T85M-4221-B	Axle (Stub) Shaft Seal Installer
T77F-4220-B1	Bearing Puller
T77F-4220-B2	Step Plate
T85M-4221-A	Differential Side Bearing Installer
T85M-4020-A1	Pinion Depth Gauge Tube
T85M-4621-A	Pinion Bearing Cone Replacer
T75L-1165-B	Axle Bearing Seal Plate
T80T-4000-C	Seal Replacer
T85M-4020-A2	Gauge Disc
T79P-4020-A21	Aligning Adapter
T76P-4020-A9	Screw
T76P-4020-A11	Handle
D83L-2100-A	Torx Drive Bit Set
TOOL-4201-C	Dial Indicator with Bracketry
D84M-4000-A	Rear Axle Mounting Kit (Use with Holding Fixture T57L-500-B)
T57L-500-B	Holding Fixture

DISASSEMBLY AND ASSEMBLY (Continued)

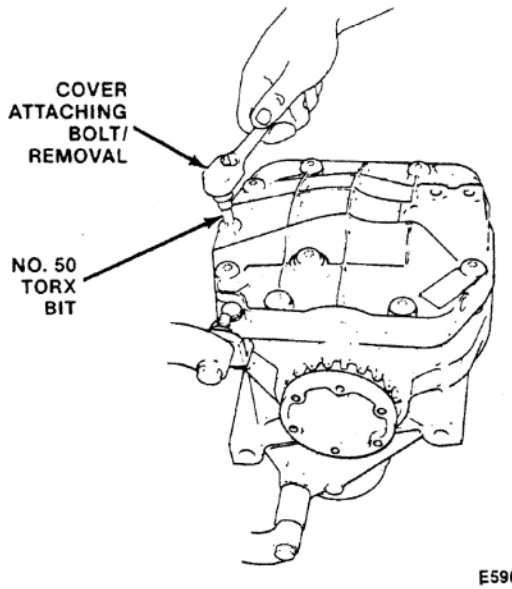
Rear Axle

1. Mount the axle in Holding Fixture T57L-500-B, or equivalent, and position a drain pan under the axle.

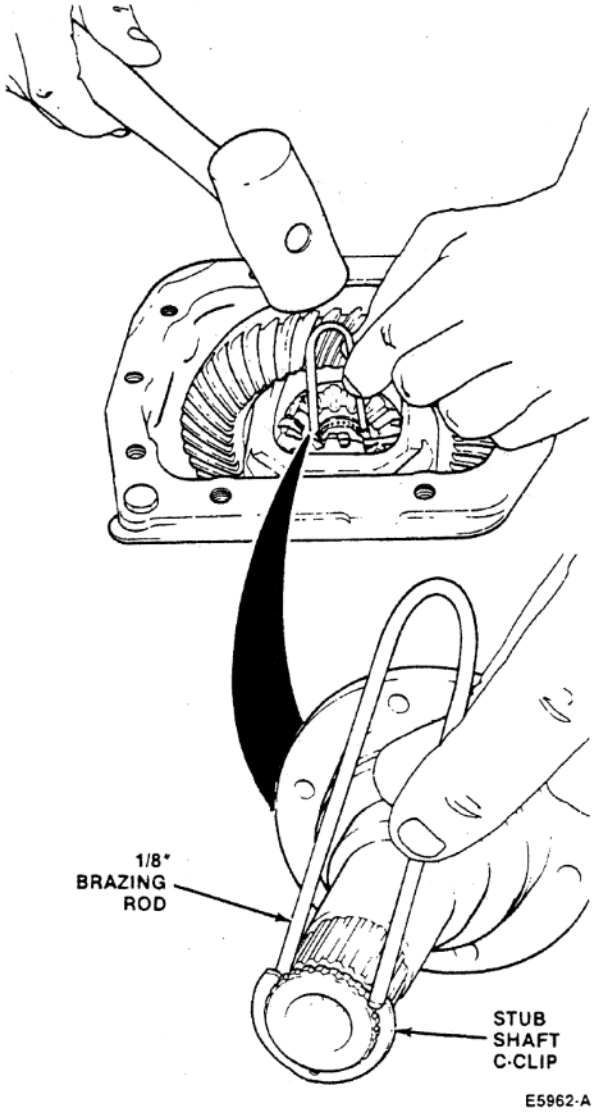


2. Remove the cover attaching bolts (number 50 torx bit). It may be necessary to tap the cover with a plastic-tipped hammer to break the seal.

   If necessary, turn the axle over and allow the lubricant to empty into the drain pan.



3. Remove the stub shaft C-clips.



4. Remove the stub shafts.

DISASSEMBLY AND ASSEMBLY

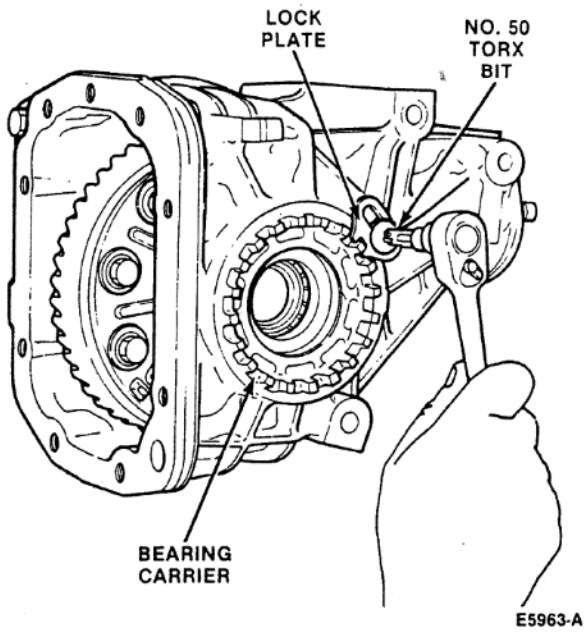
REAR AXLE

Disassembly (Continued)

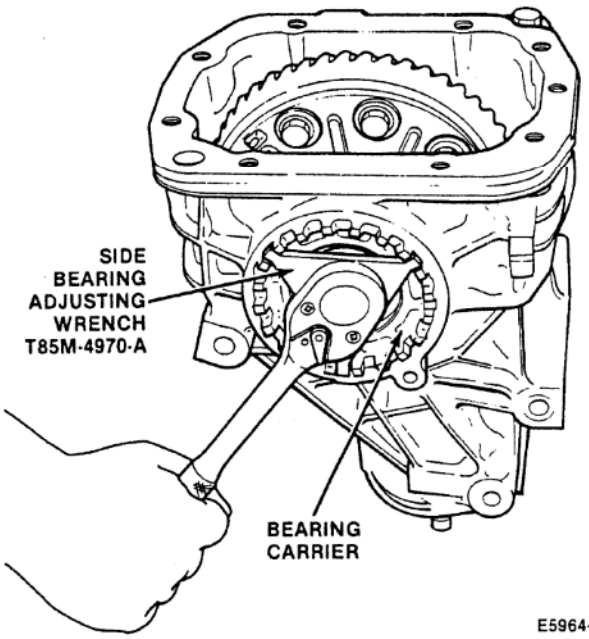
5. Mark the bearing carriers left and right for assembly reference, as the bearing carriers must be reinstalled in their original case bores.

6. Remove the stub shaft oil seals at this point, using Bearing Cup Puller D78P-1225-B, or equivalent. If the seal removal tool is not available, leave the seals in the carriers. The seals can be removed in a later step after the bearing carriers are removed from the case.

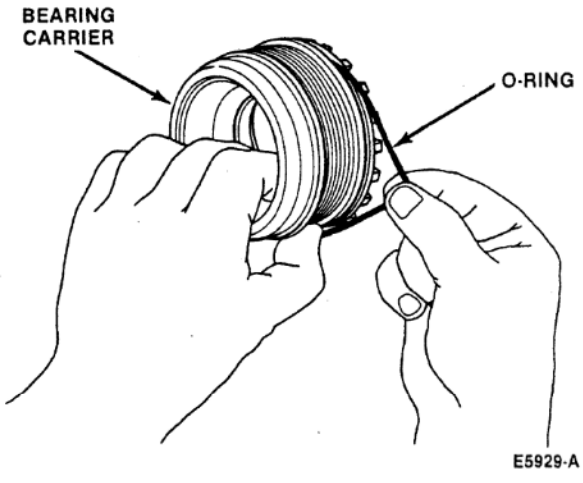
7. Remove the bearing carrier lock plates (number 50 torx bit).



8. Remove the bearing carriers using Side Bearing Adjusting Wrench T85M-4970-A, or equivalent.



9. Remove the O-rings from the bearing carriers and discard.

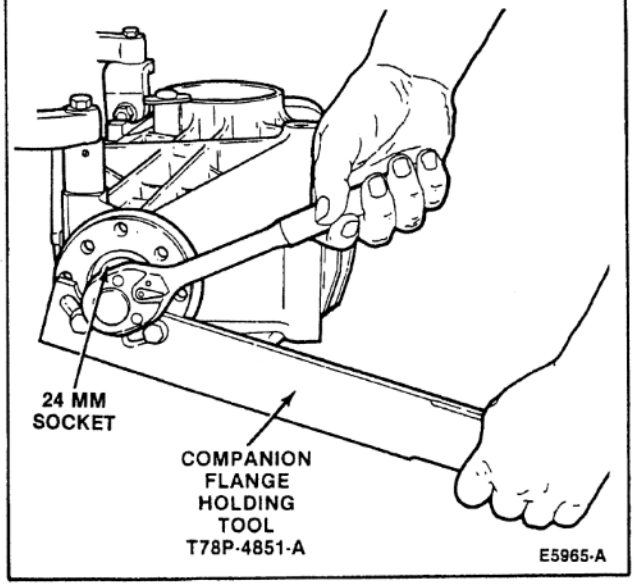


DISASSEMBLY AND ASSEMBLY

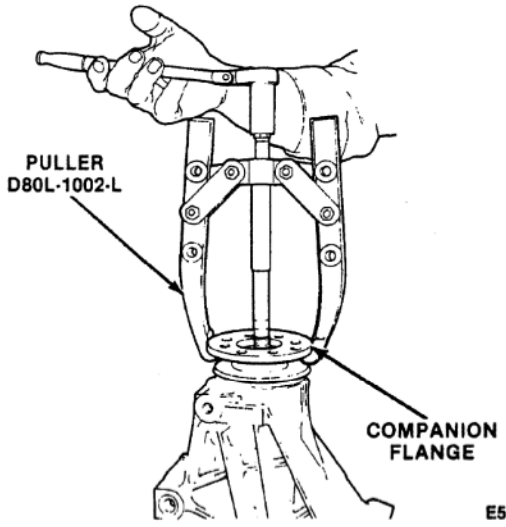
REAR AXLE

Disassembly (Continued)

10. Remove the differential assembly from the case.
11. Remove the companion flange attaching nut (24 mm socket). Use Companion Flange Holding Tool T78P-4851-A, or equivalent, to prevent rotation of the pinion shaft.

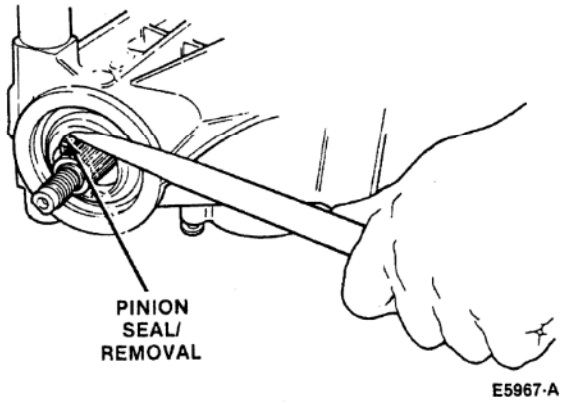


12. Remove the companion flange, using Puller D80L-1002-L, or equivalent.

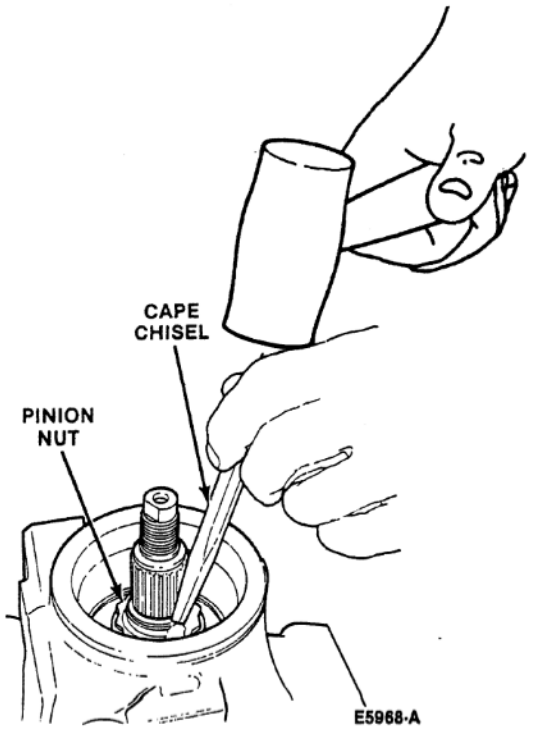


13. Remove the pinion oil seal, using a pry bar or large screwdriver.

CAUTION: Use care to prevent goughing of the seal bore in the aluminum case.



14. Remove the staking from the pinion nut using a cape chisel.



DISASSEMBLY AND ASSEMBLY

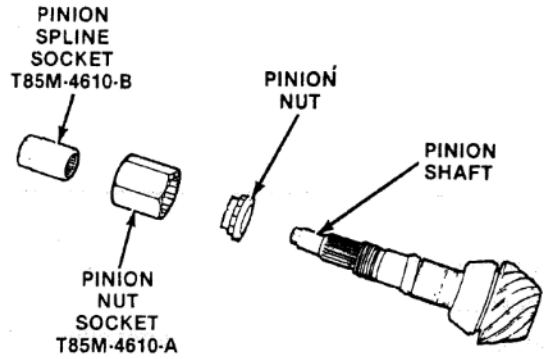
REAR AXLE

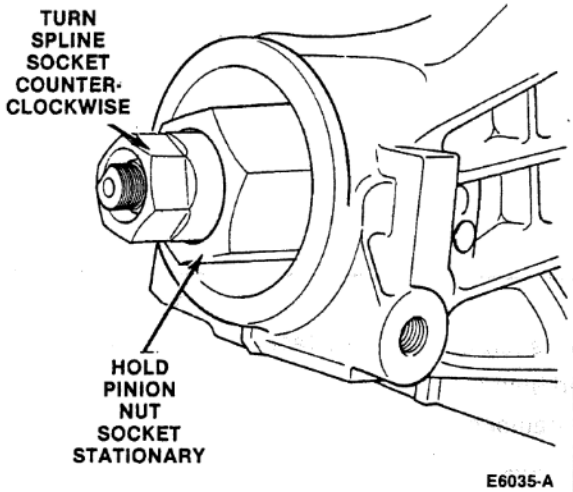
Disassembly (Continued)

15. Remove the pinion nut, using Pinion Nut Socket T85M-4610-A and Pinion Spline Socket T85M-4610-B, or equivalents.

NOTE: The pinion nut has a left-hand thread. To remove the nut, turn the spline socket counterclockwise while holding the pinion nut socket stationary.

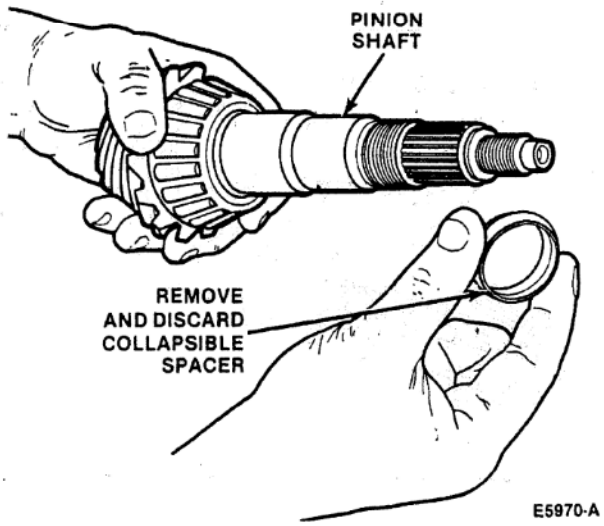
Discard the pinion nut. It must not be reused.





16. Remove the pinion with the pinion inner bearing and collapsible spacer.

17. Remove the collapsible spacer from the pinion shaft and discard.



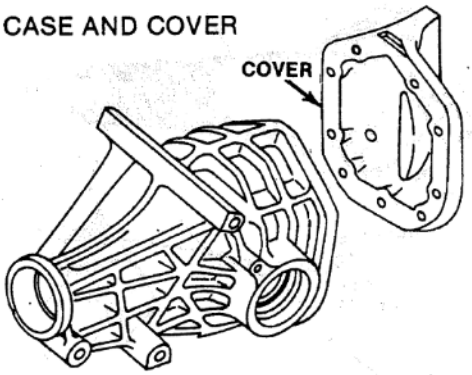
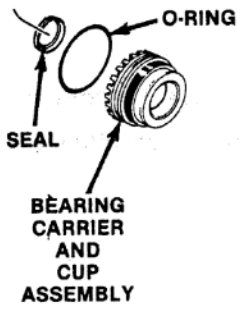
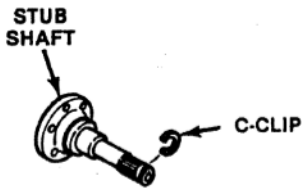
NOTE: Do not reuse the collapsible spacer.

18. Remove the pinion outer bearing from the case.

DISASSEMBLY AND ASSEMBLY

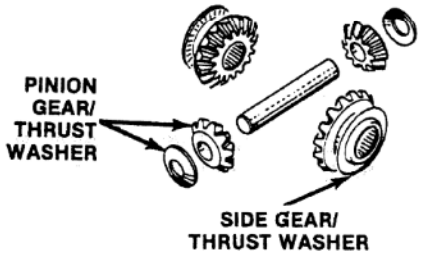
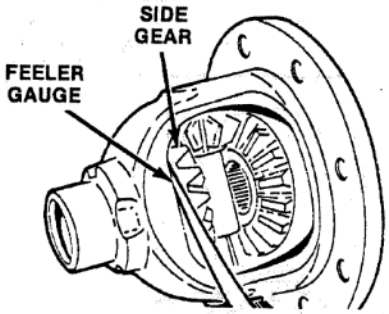
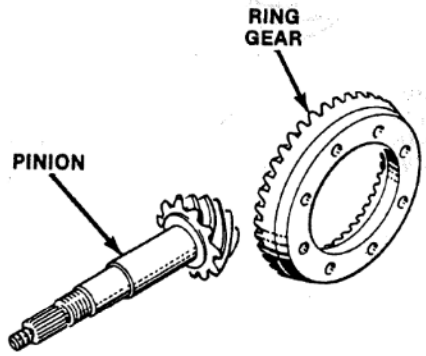
COMPONENT INSPECTION CHART
REAR AXLE

NOTE: Thoroughly clean all parts in solvent and blow dry with compressed air. If the bearings are dried with compressed air, do not allow the roller and cage to spin on the bearing race. Damage to the rollers, cage, and race may occur.

COMPONENT	CHECK FOR
CASE AND COVER 	• Threaded holes that are stripped, cross threaded, or otherwise damaged • Nicks or burrs on the machined faces that could cause improper sealing or misalignment of bearings or other components • Cracks or other damage
BEARING CARRIER 	• Worn or damaged seal • Damaged bearing cups • Nicks or burrs on machined surfaces—especially in the O-ring groove
STUB SHAFT 	• Nicked or scored sealing surface • Damaged spline • Worn or damaged C-clip groove • Loss of C-clip tension

DISASSEMBLY AND ASSEMBLY

COMPONENT INSPECTION CHART (Continued)
REAR AXLE

COMPONENT	CHECK FOR
DIFFERENTIAL CASE  	• Oversize pinion shaft bore • Cracks or other damage
PINION AND SIDE GEARS  	• Chipping, galling, and wear on each gear tooth • Worn thrust washers • Worn or damaged bores • Excessive clearance between the side gears and thrust washers using a feeler gauge. If the clearance is more than 0.15 mm (0.006 in.), replace the thrust washers
RING AND PINION GEARS  	• Chipping, galling, and wear on each gear tooth • Scoring
BEARINGS	Refer to the bearing inspection chart at the end of Group 11.

DISASSEMBLY AND ASSEMBLY

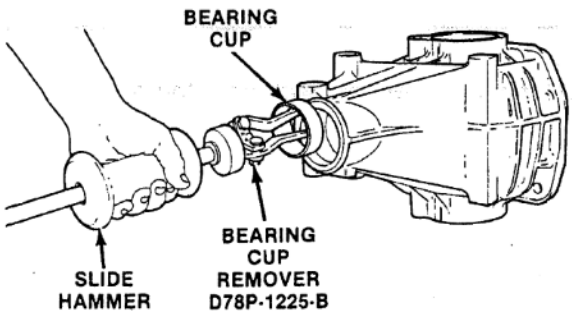
PINION BEARING CUPS

CAUTION: Remove and install the bearing cups, one at a time. Never remove both at the same time. One bearing cup must remain in the case at all times.

Removal

Remove a bearing cup from the case, using Bearing Cup Remover D78P-1225-B, or equivalent. Discard the pinion depth shim under the inner bearing cup.

NOTE: Do not reuse the shim.



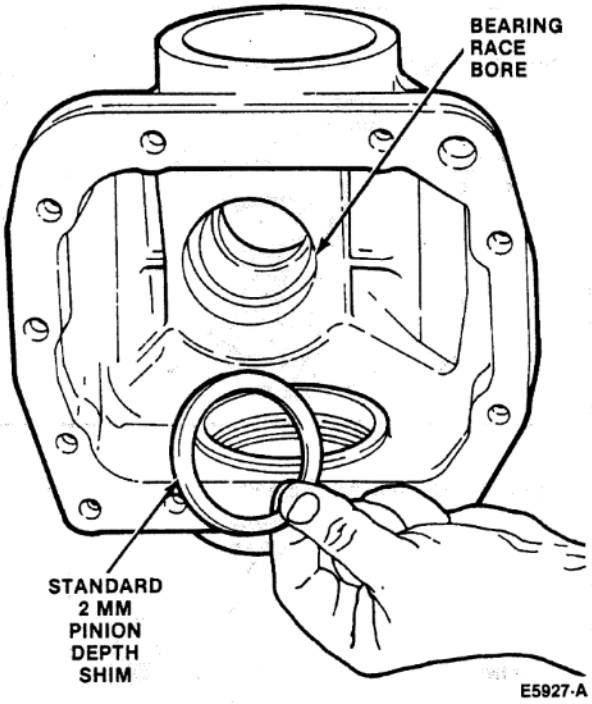
NOTE: OUTER CUP REMOVAL SHOWN FOR CLARITY

E5926-A

Installation

1. Inspect the bearing cup bore for nicks, scratches, or burrs. Minor imperfections can be polished out with a fine grit sandpaper.

2. Position a standard 2 mm pinion depth shim in the inner bearing cup bore.



E5927-A

3. Lightly oil the bearing cup bore.

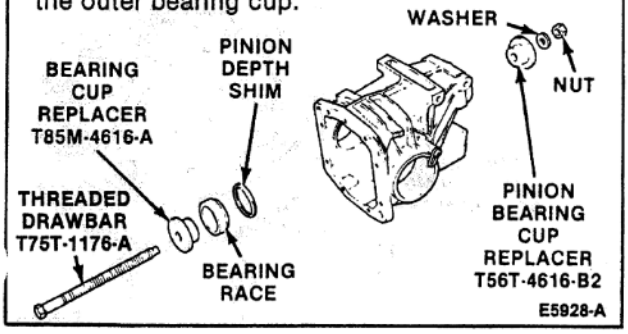
DISASSEMBLY AND ASSEMBLY

PINION BEARING CUPS

Installation (Continued)

4. Install the inner bearing cup in the bore using:
   - Pinion Bearing Cup Replacer T85M-4616-A (position this tool against the inner cup)
   - Pinion Bearing Cup Replacer T56T-4616-B2 (position this tool against the outer cup)
   - Drawbolt T75T-1176-A, or equivalents

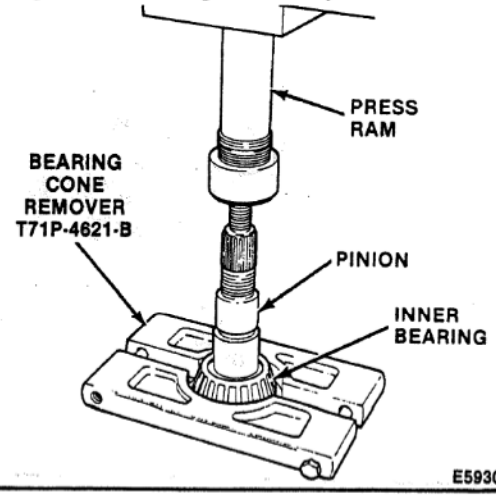
After installing the inner bearing cup, the outer bearing cup can be removed and installed, using the same tools and procedure outlined for the inner bearing cup. Do not install a shim under the outer bearing cup.



PINION INNER BEARING

Remove the pinion inner bearing, using Pinion Bearing Cone Remover T71P-4621-B, or equivalent, and a press.

NOTE: Do not install a new bearing at this time. The bearing will be used with the pinion depth gauge tools during assembly of the axle.



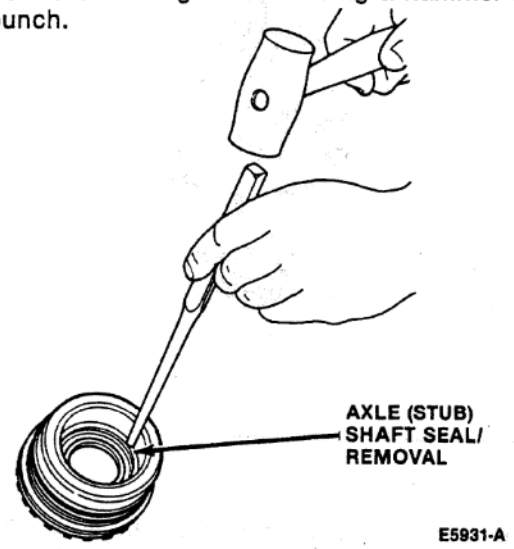
DIFFERENTIAL SIDE BEARING CUPS

The differential side bearing cups are serviced only as part of the bearing carrier assembly.

AXLE (STUB) SHAFT SEALS

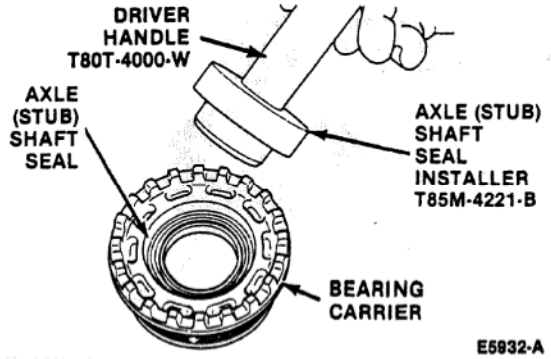
Removal

If not removed during disassembly of the axle, the axle (stub) shaft seals can now be removed from the bearing carriers using a hammer and punch.



Installation

Install the axle (stub) shaft seals using Axle (Stub) Shaft Seal Installer T85M-4221-B and Driver Handle T80T-4000-W, or equivalents.

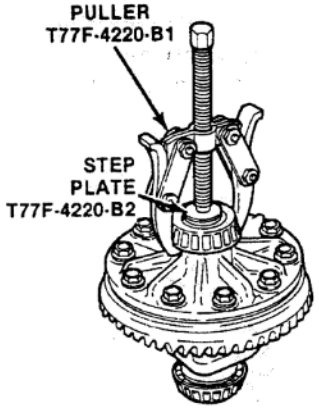


DISASSEMBLY AND ASSEMBLY

DIFFERENTIAL SIDE BEARING CONES

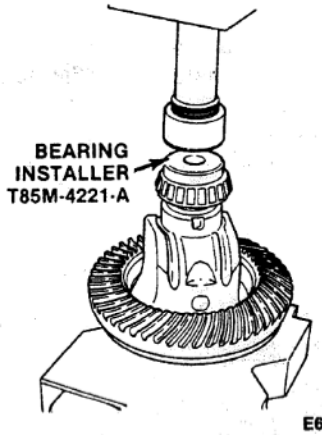
Removal

If the differential side bearings are to be replaced, remove the bearing cones from the differential assembly, using Bearing Puller T77F-4220-B1 and Step Plate T77F-4220-B2, or equivalent.



Installation

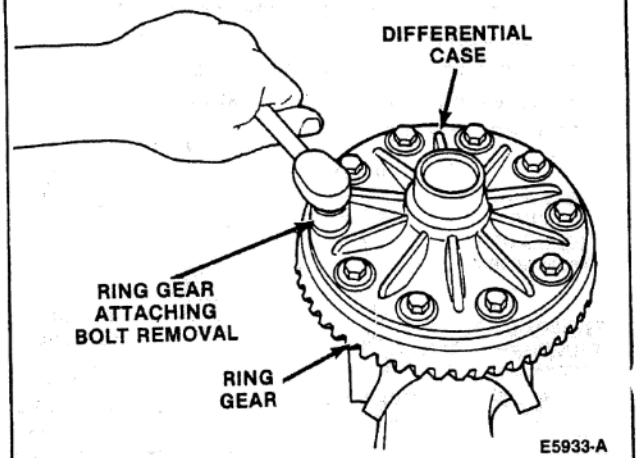
Use Differential Side Bearing Installer T85M-4221-A, or equivalent, to press new bearings onto the differential case hubs.



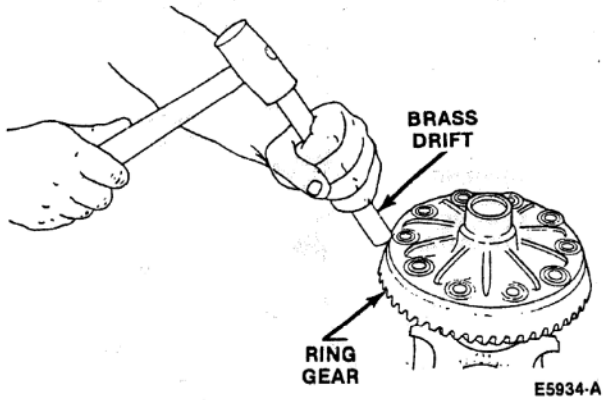
DIFFERENTIAL CASE

Disassembly

1. Remove the ten bolts securing the ring gear to the differential case flange.

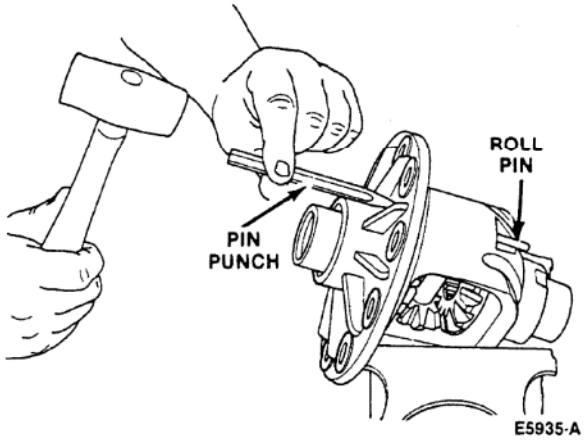


2. Drive the ring gear off the differential case, using a brass drift and a hammer.

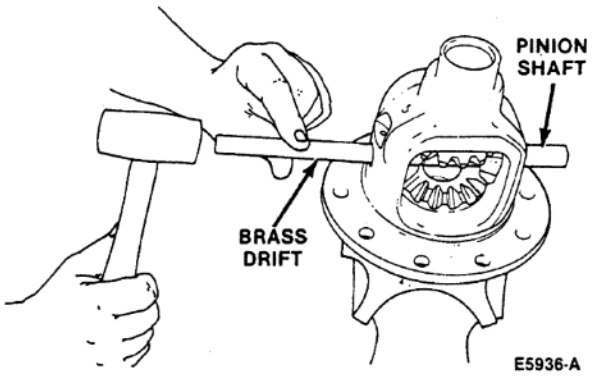


DISASSEMBLY AND ASSEMBLY (Continued)

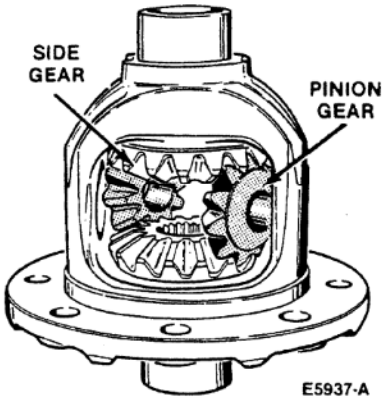
3. Drive the pinion shaft roll pin out of the case with a suitable pin punch.



4. Drive the pinion shaft out of the case, using a brass drift.

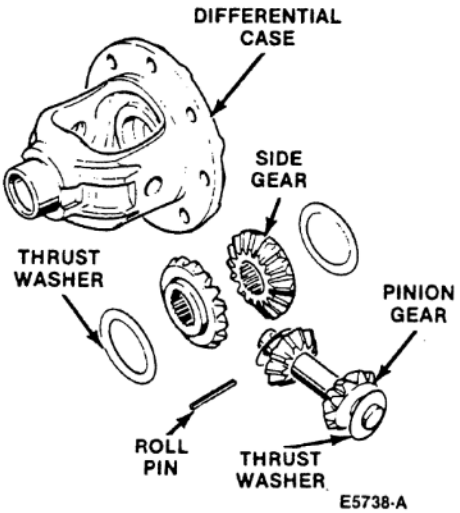


5. Rotate the side gears until the pinions revolve into the openings in the case. Remove the pinions, side gears and thrust washers.



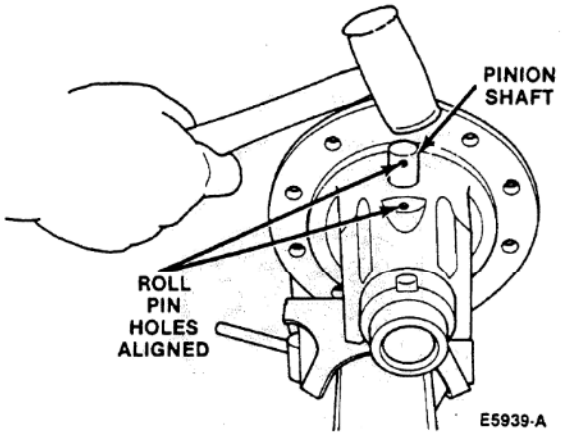
Assembly

1. Install the thrust washers on the side gears and position in the differential case.
2. Install the thrust washers on the pinions and mesh them with the side gears, opposite each other. Rotate the side gears to position the pinions in the case.

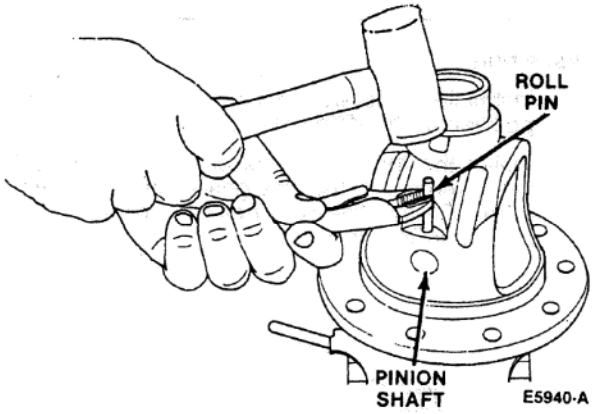


DISASSEMBLY AND ASSEMBLY (Continued)

3. Install the pinion shaft, aligning the roll pin holes in shaft and case.

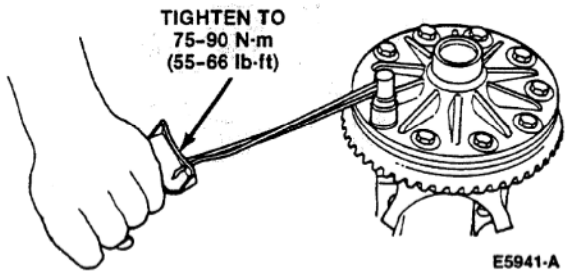


4. Install the pinion shaft roll pin.



5. Position the ring gear on the differential case and install new mounting bolts. Tighten the screws progressively in a criss-cross pattern to draw the ring gear evenly onto the case.

   Torque the screws to 75 to 90 N·m (55 to 66 lb-ft).

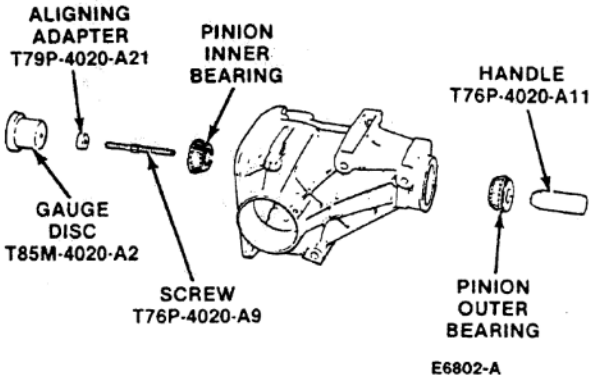


Rear Axle

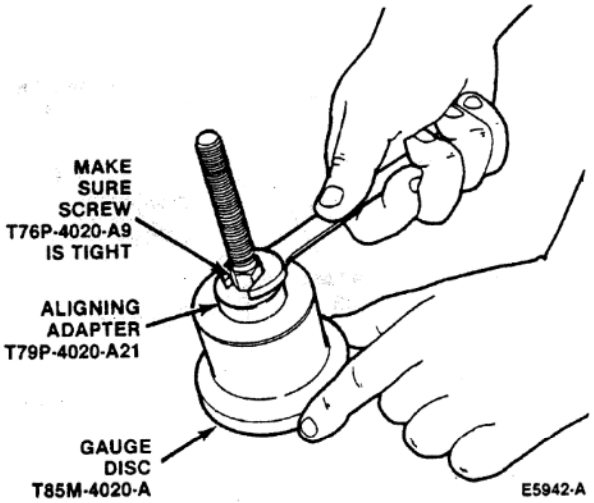
Assembly

1. Lubricate the pinion bearings with the specified axle lubricant.
2. Assemble the pinion bearings and dummy pinion depth tools in the rear axle case.

The illustration below shows the arrangement of the tools and bearings in the case.



NOTE: Be sure the gauge screw is tight in the gauge disc before assembling the tool.



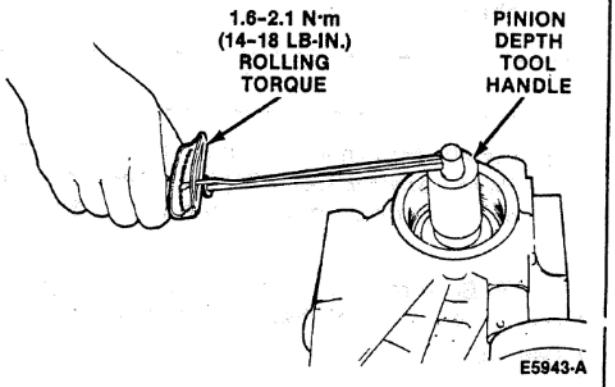
DISASSEMBLY AND ASSEMBLY

REAR AXLE

Assembly (Continued)

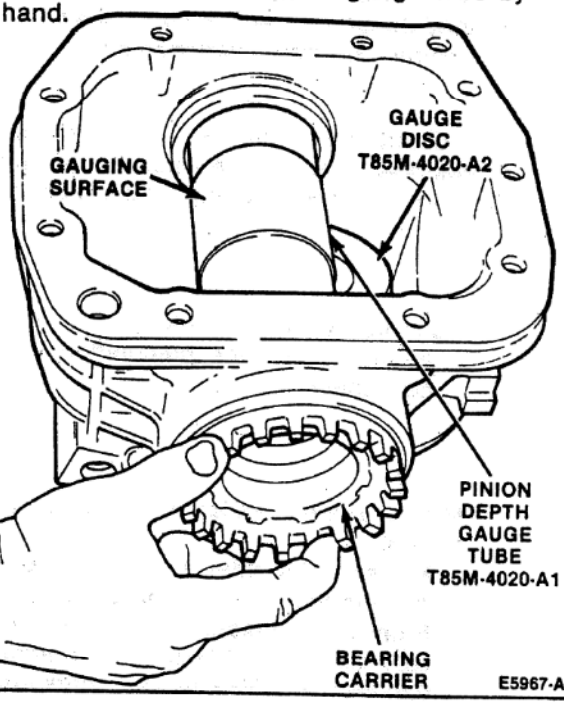
3. Hold the gauge disc stationary and gradually tighten the tool handle until a rolling torque of 1.6 to 2.1 N·m (14 to 18 lb-in.) is measured at the pinion depth tool handle.

NOTE: Before making the rolling torque check, turn the tool shaft ten times to seat the bearings. Any time the tool is loosened or tightened, rotate the pinion ten times before another rotational torque check is made.



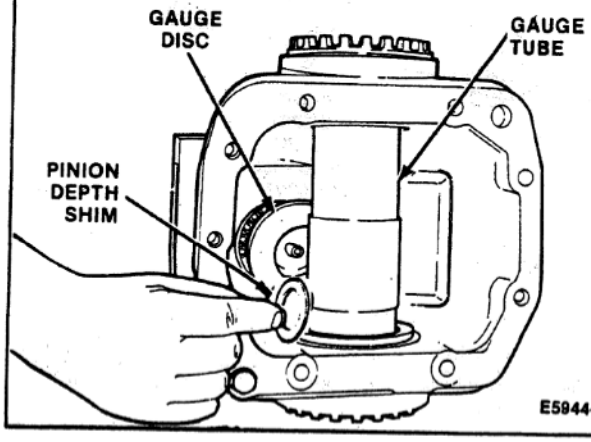
4. Position Pinion Depth Gauge Tube T85M-4020-A1 in the case. Be sure the tube gauging surface is aligned with the gauge disc and then install the bearing carriers. The bearing carriers must be installed in their original case bores and WITHOUT the O-ring seals.

Thread the bearing carriers evenly into the case. When the carriers contact the gauge tube, snug them down to remove all endplay from the tube. The carriers are properly tightened when a moderate amount of effort is required to turn the gauge tube by hand.



5. From the available selective pinion depth shims, determine the clearance between the gauge tube and gauge disc.

NOTE: The correct shim thickness has been determined when a slight drag is felt between the shim and gauging surfaces.



DISASSEMBLY AND ASSEMBLY

REAR AXLE

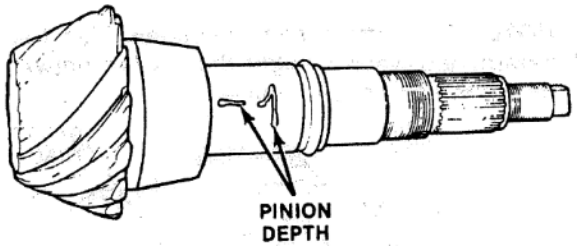
Assembly (Continued)

6. The clearance check in Step 5 has determined the pinion depth shim thickness for a "nominal" or "zero" variance pinion.

   To determine if this is the correct shim thickness, inspect the pinion shaft for a pinion variance marking and proceed as follows:

   - No pinion variance marking
     —A pinion variance calculation is not necessary.

   - Minus pinion variance marking (−1 to −3)
     —Measure the shim from Step 5 with a micrometer to determine its thickness. From this measured thickness, ADD 0.01 mm or 0.0004 in. (−1 marking), 0.02 mm or 0.0008 in. (−2 marking) or 0.03 mm or 0.0012 in. (−3 marking), depending upon the pinion variance marking.



E5945-A

EXAMPLE:

Measured Shim Thickness	1.18 mm	0.0465 in.
Pinion Marking −2	+0.02 mm	+0.0008 in.
Required Shim Thickness	1.20 mm	0.0473 in.

   - Positive pinion variance marking (+1 to +3)
     —Measure the shim from Step 5 with a micrometer to determine its thickness. From this measured thickness, SUBTRACT 0.01 mm or 0.0004 in. (+1 marking), 0.02 mm or 0.0008 in. (+2 marking) or 0.03 mm or 0.0012 in. (+3 marking), depending upon the pinion variance marking.

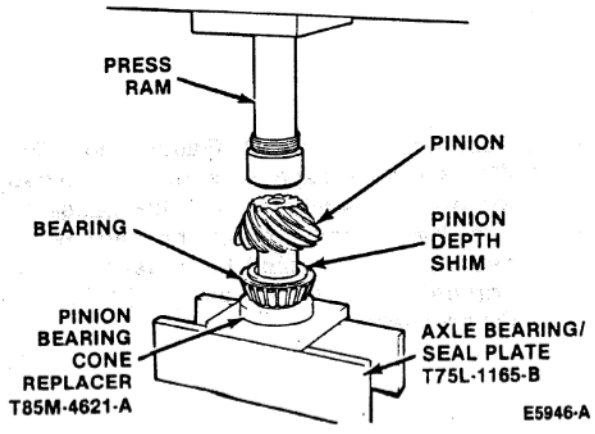
EXAMPLE:

Measured Shim Thickness	1.18 mm	0.0465 in.
Pinion Marking +2	−0.02 mm	−0.0008 in.
Required Shim Thickness	1.16 mm	0.0457 in.

7. Remove the bearing carriers, pinion depth tools, and bearings.
8. Install the pinion depth shim on the pinion shaft.

9. Install the inner pinion bearing, using Pinion Bearing Cone Replacer T85M-4621-A and Axle Bearing/Seal Plate T75L-1165-B.

NOTE: Be sure the pinion depth shim is in position on the pinion shaft before installing the bearing.



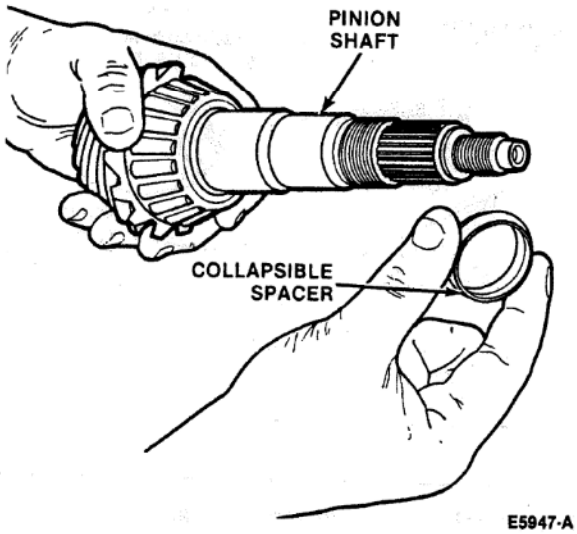
E5946-A

DISASSEMBLY AND ASSEMBLY

REAR AXLE

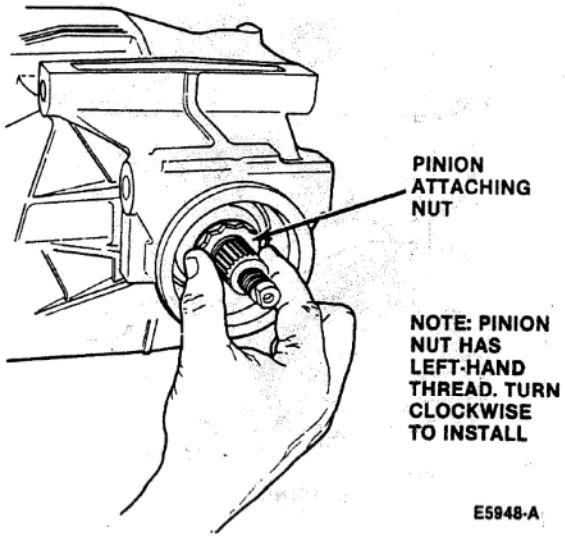
Assembly (Continued)

10. Install a new collapsible spacer on the pinion shaft.

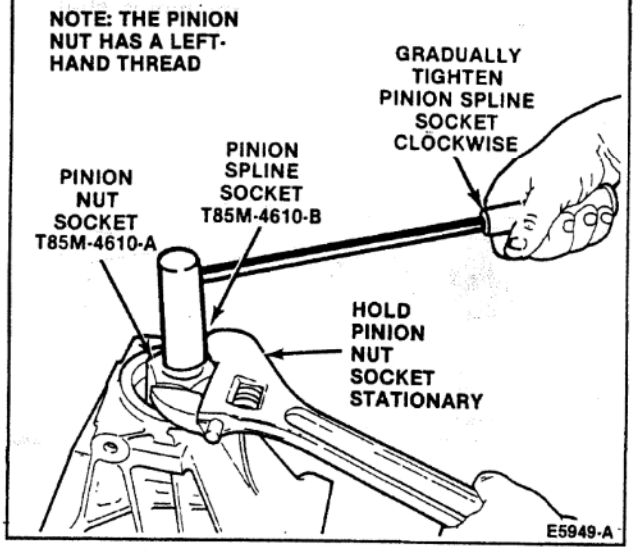


11. Position the pinion in the case and install the outer bearing. Lubricate the bearings before installing in the case.

12. Install the pinion nut.



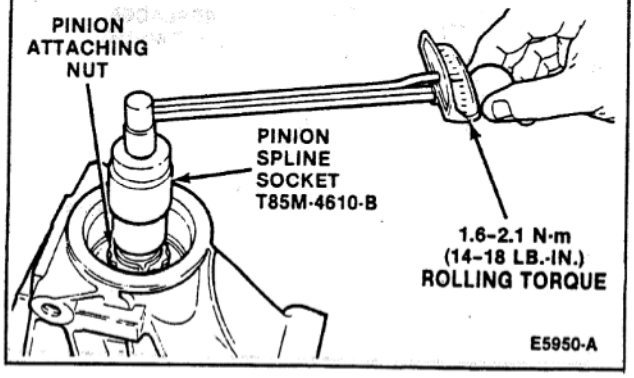
13. To preload the pinion bearings, gradually tighten the pinion nut, using Pinion Nut Socket T85M-4610-A and Pinion Spline Socket T85M-4610-B.



Each time the nut is tightened, check the pinion shaft rolling torque (bearing preload), using an inch pound torque wrench and Pinion Spline Socket T85M-4610-B.

Continue tightening the pinion nut in small increments until a rolling torque of 1.6 to 2.1 N·m (14 to 18 lb-in.) is measured at the pinion shaft.

CAUTION: An increasing resistance will be felt as the pinion bearing preload is increased by the action of the collapsible spacer. If the nut is tightened beyond the specified rolling torque, remove the pinion, install a new collapsible spacer and repeat the pinion bearing preload procedure.

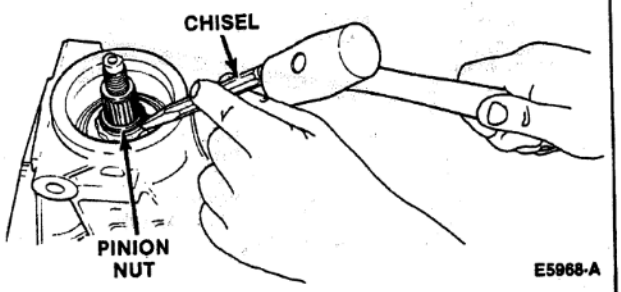


DISASSEMBLY AND ASSEMBLY

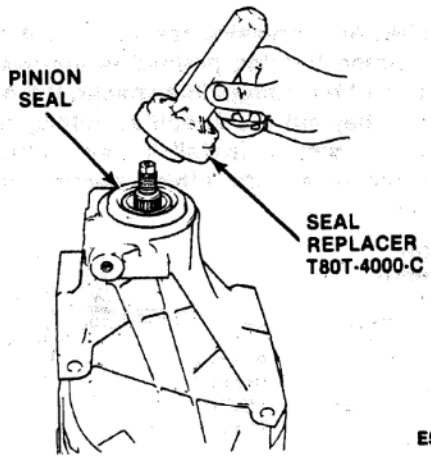
REAR AXLE

Assembly (Continued)

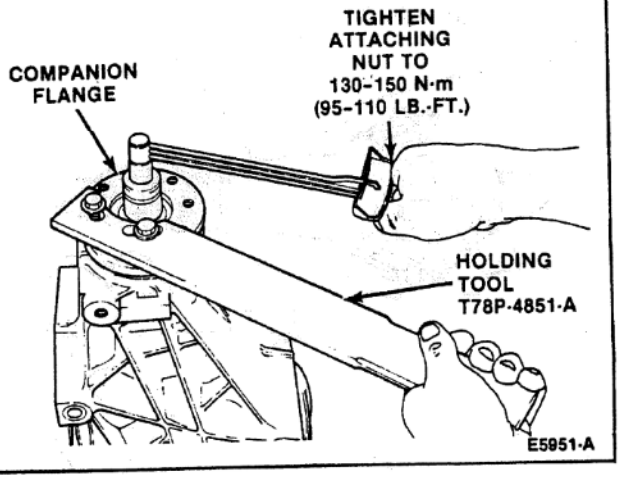
14. Stake the pinion nut to the pinion shaft.



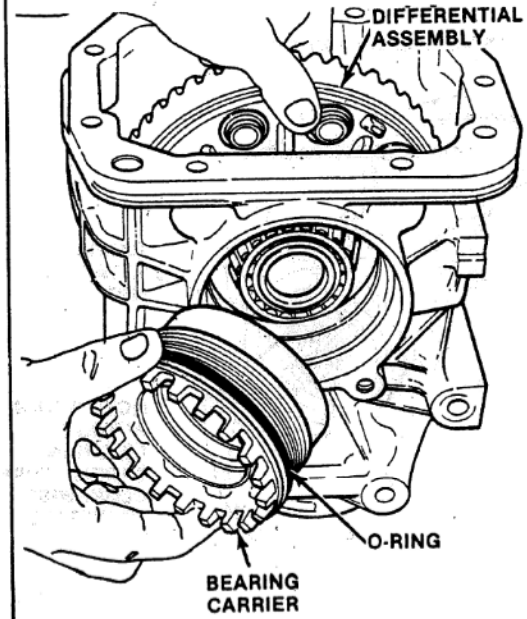
15. Install the pinion seal using Seal Replacer T80T-4000-C, or equivalent.



16. Install the pinion flange and attaching nut. Tighten the attaching nut to 130 to 150 N·m (95 to 110 lb-ft). Use Companion Flange Holding Tool T78P-4851-A, or equivalent, to prevent rotation of the pinion shaft.



17. Position the differential assembly in the case.
18. Install new O-rings on the bearing carriers and install the carriers in their original positions. Lubricate the bearing carrier threads and O-rings with the specified axle lubricant before installing in the case.



DISASSEMBLY AND ASSEMBLY

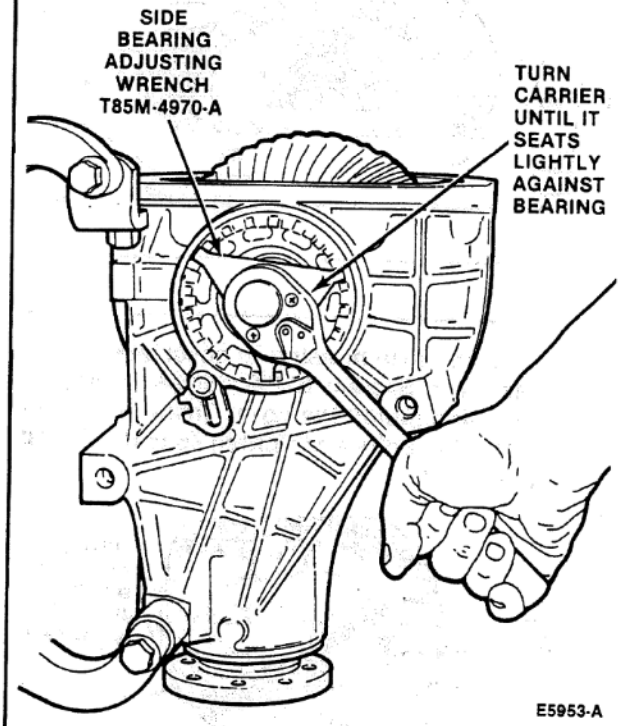
REAR AXLE

Assembly (Continued)

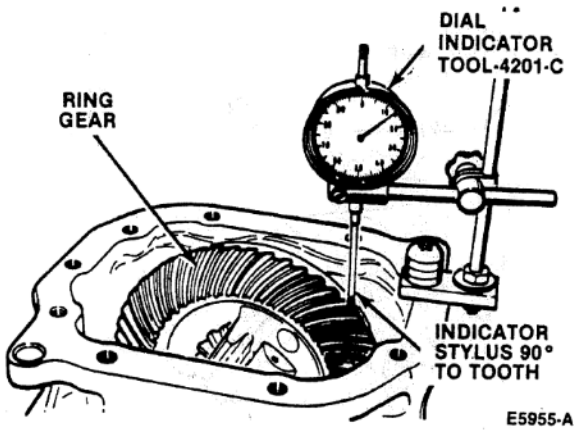
19. Using Side Bearing Adjusting Wrench T85M-4970-A, turn the bearing carriers into the axle case until they lightly seat against the differential bearings.

    This seating action can be felt as the bearing carrier cups contact the differential bearings.

NOTE: When the bearing carrier O-rings enter the case, the turning effort will increase due to the drag between the O-ring and the case. Even with the increased drag, the seating action will be felt as the bearing carrier cup contacts the bearing.



20. Mount Dial Indicator TOOL-4201-C, or equivalent, on the axle housing and position the stylus to contact a ring gear tooth at a ninety-degree angle.



21. "Rock" the ring gear forward and backward and note the reading on the dial indicator.

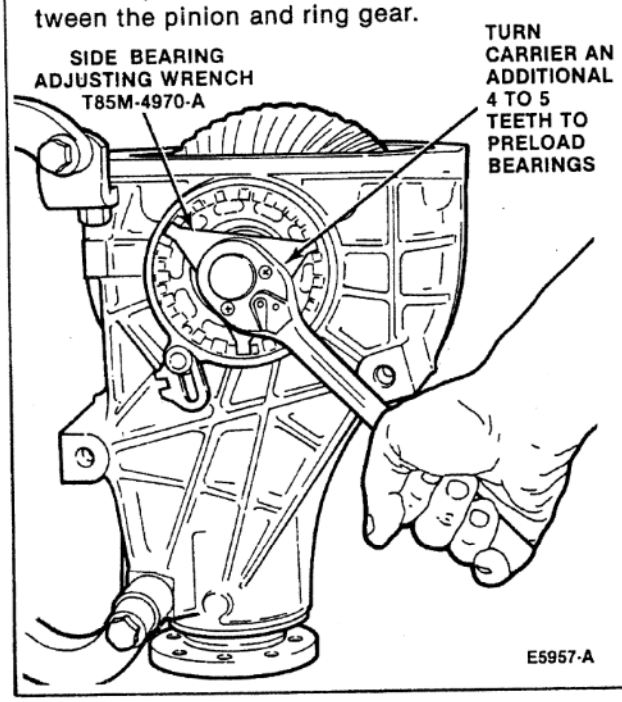
22. Thread the bearing carriers into the case in EQUAL amounts until the dial indicator reads a backlash of 0.01 mm (0.0004 in.).

DISASSEMBLY AND ASSEMBLY

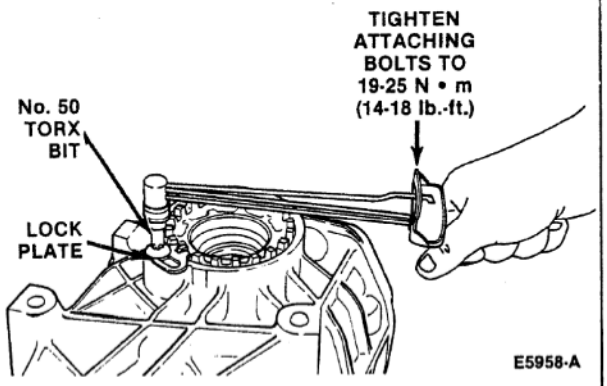
REAR AXLE ASSEMBLY
Assembly (Continued)

23. After the minimum backlash of 0.01 mm (0.0004 in.) is set, tighten the bearing carrier on the differential side of the case an additional four to five teeth of the carrier to preload the bearings.

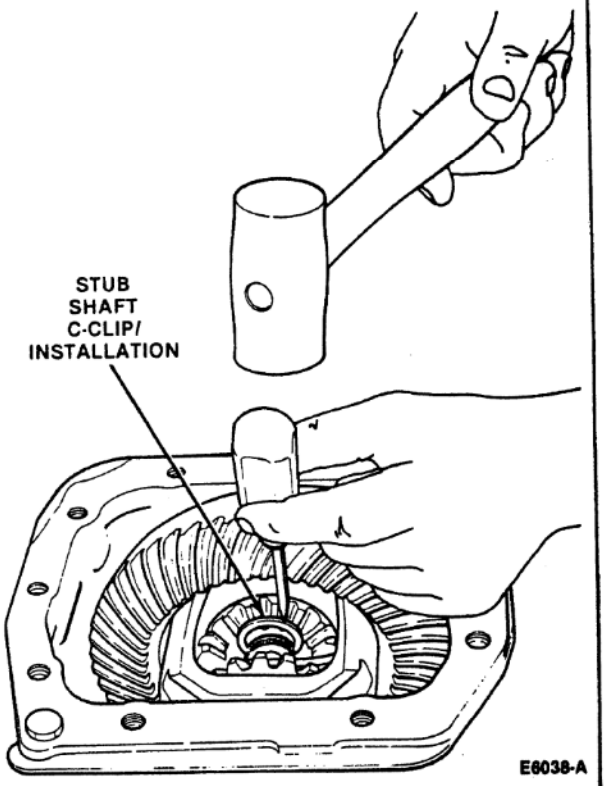
NOTE: If steps 19 through 23 has been properly done, the correct amount of backlash, 0.10 to 0.17 mm (0.004 to 0.007 in.) should now exist between the pinion and ring gear.



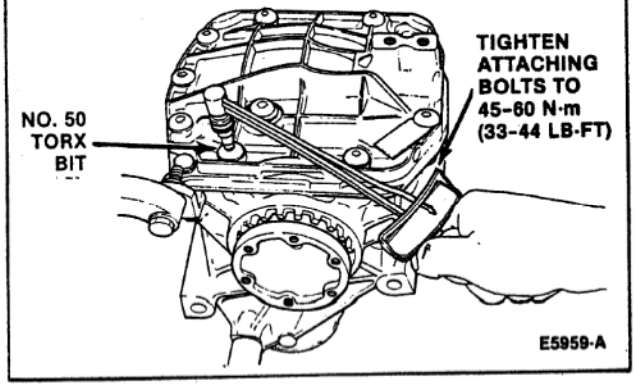
24. Install the bearing carrier lock plates (number 50 torx bit). Tighten the attaching bolts to 19 to 25 N·m (14 to 18 lb-ft).



25. Install the stub shafts.
26. From the available selective C-clips, install the thickest possible clip in each stub shaft groove.



27. Coat the axle housing to cover sealing surface with Sealant E1FZ-19562-A, or equivalent, and install the cover. Install the cover attaching bolts and tighten 45 to 60 N·m (33 to 44 lb-ft).

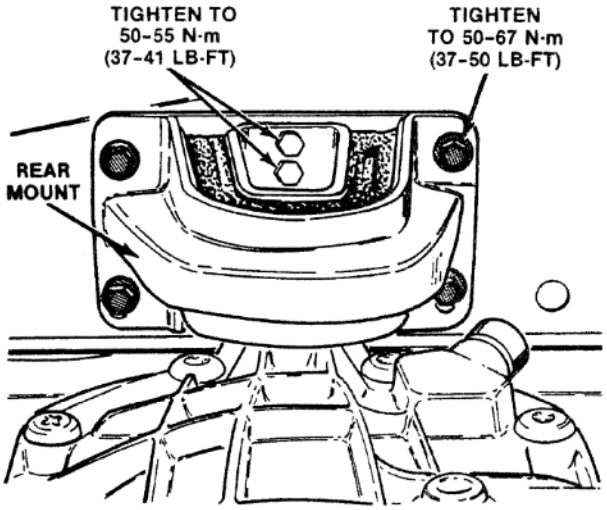


GENERAL SERVICE PROCEDURES

Mounting Flange Clearance Check

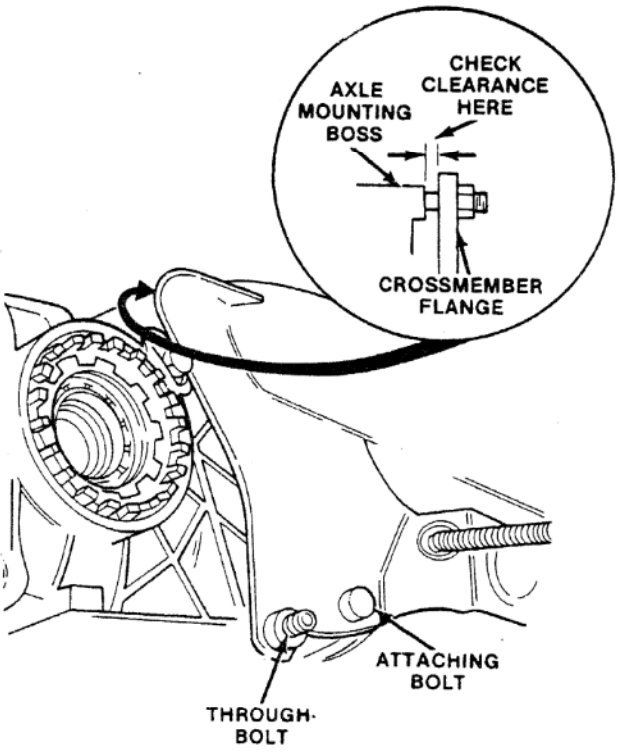
If the axle case, axle assembly or suspension crossmember has been replaced, it is important to determine whether a gap exists between the rear axle mounting boss and the crossmember mounting flanges. If a gap is found, selective shims must be installed to compensate for the clearance.

1. Install the rear mount on the axle housing rear cover. Tighten the attaching bolts to 50 to 55 N·m (37 to 41 lb-ft).
2. Lift the assembly into position between the crossmember flanges.
3. Install the through-bolt and the four axle bolts to crossmember attaching bolts. Do not tighten the bolts.
4. Position the axle housing rear mount against the body and secure with four bolts. Tighten attaching bolts as shown.



E6032-B

5. Tighten the front lower attaching bolt to 70-90 N·m (51-66 lb-ft).
6. Tighten the through-bolt to 70-90 N·m (51-66 lb-ft).
7. Using a feeler gauge, check the clearance between the crossmember flanges and the rear axle mounting boss.



A5761-A

8. Select and install the appropriate shims between the crossmember and axle.
9. Tighten the attaching bolts to 70-90 N·m (51-66 lb-ft).

SECTION 15-60 DRIVESHAFT

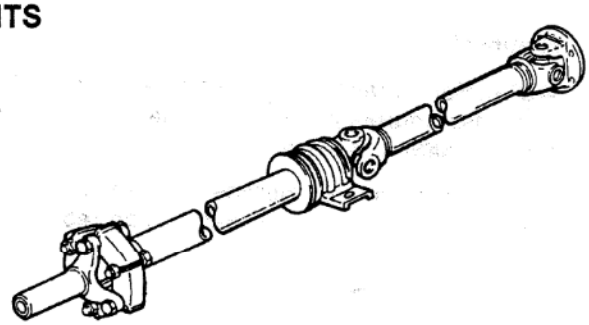
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Driveshaft 2

DISASSEMBLY AND ASSEMBLY
Universal Joints 3
Support Bearing 3



DESCRIPTION

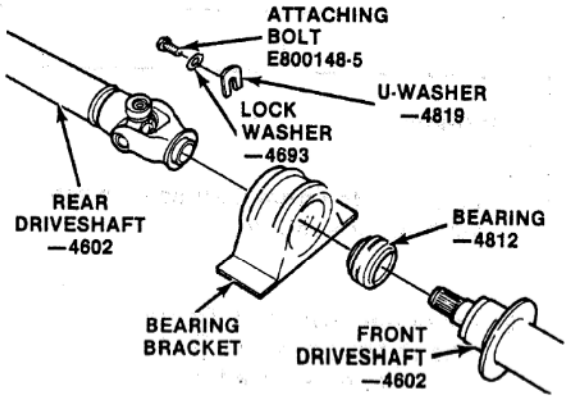
A rear wheel drive vehicle, such as the XR4Ti, requires a driveshaft which will connect the transmission output shaft to the differential pinion. Because it is transferring engine torque between these two major powertrain components, smooth and vibration-free rotation of the driveshaft is extremely important. To minimize rotational vibration, the driveshaft has been constructed of two separate driveshafts which are splined together and supported by a roller bearing.

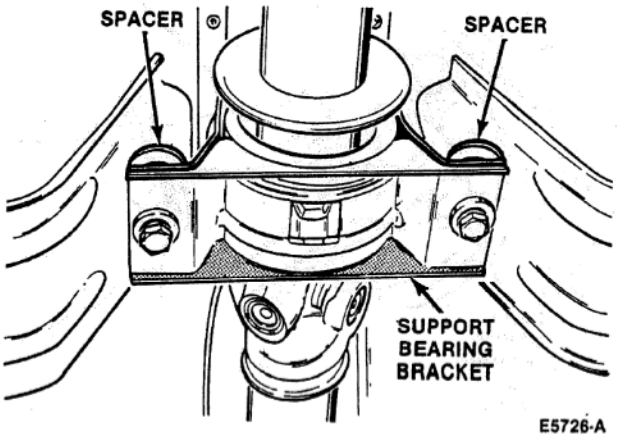
The front and rear shafts are constructed differently to allow the driveshaft assembly to compensate for varying driveline conditions.

The front driveshaft includes a large, rubber torque damper, which will absorb twisting action caused by varying torque loads. The rear driveshaft includes the universal joints, which allow the driveshaft to smoothly rotate through variable driveline angles.

Spacers are installed between the support bearing mounting bracket and the body floor plan. If the driveshaft is removed, make sure these spacers are in position during installation.

For service, the front and rear driveshafts are supplied only as one assembly. The rubber torque damper and U-joints are not serviced separately. The U-joints cannot be replaced due to a staking operation which prevents removal of the trunnion bearings. The support bearing is available as a separate component.





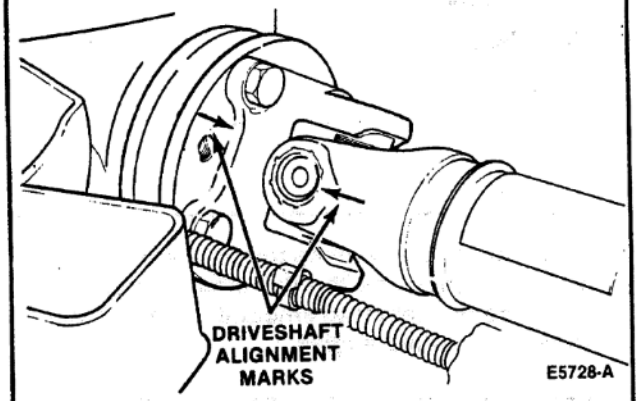
REMOVAL AND INSTALLATION

DRIVESHAFT

Removal

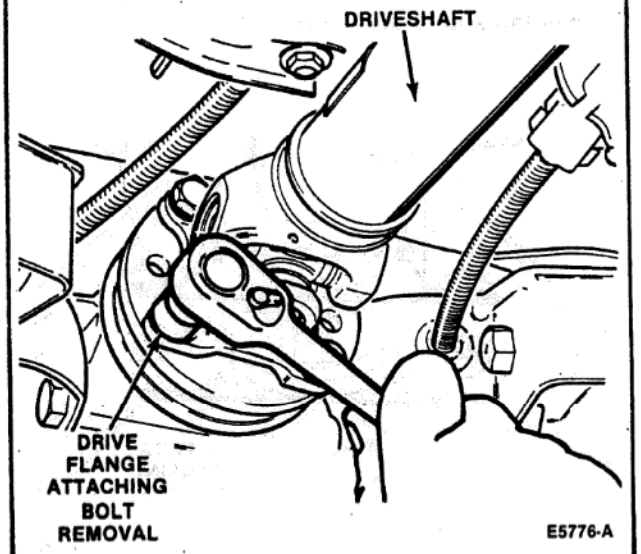
NOTE: For installation reference, always scribe alignment marks on the driveshaft and pinion flanges before removal.

If the driveshaft is improperly indexed during installation, a driveline vibration can result.

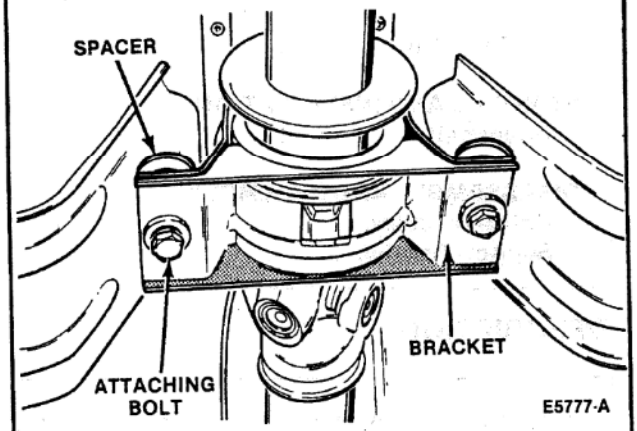


1. Place the transmission gear selector in neutral to allow rotation of the driveshaft.
2. Raise the vehicle.

3. Remove the driveshaft flange attaching bolts.



4. Remove the support bearing bracket attaching bolts.



NOTE: During production, the driveshaft position is set when spacers are installed between the support bearing bracket and the floor pan. These spacers must be installed in their original position. Failure to install the spacers could cause a driveline vibration.

5. Disengage the driveshaft from the pinion flange.
6. Hold the support bearing and pull the driveshaft rearward to remove from the transmission.

Installation

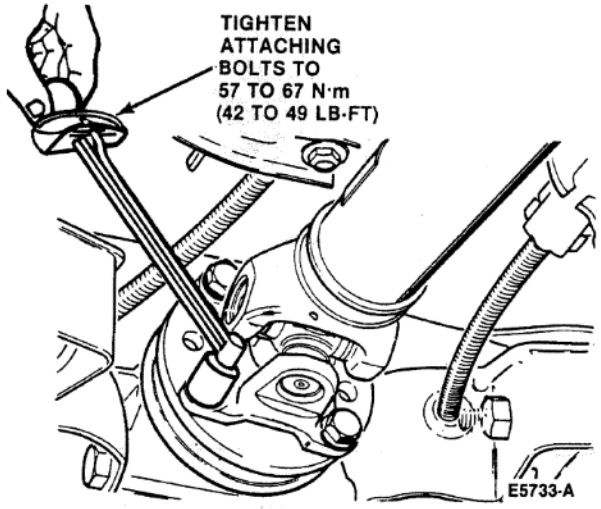
1. Lubricate the driveshaft splines with C1AZ-19590-B, or equivalent.
2. Install the driveshaft. Do not allow the slip yoke to bottom on the transmission output shaft with excessive force.

REMOVAL AND INSTALLATION

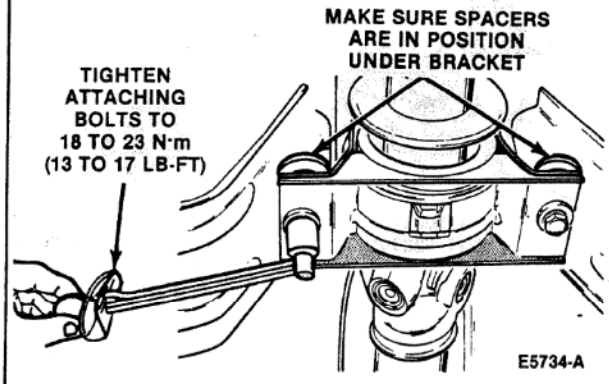
DRIVESHAFT

Installation (Continued)

3. Align the scribe marks made during removal and install the flange attaching bolts. Tighten the attaching bolts to 57 to 67 N·m (42 to 49 lb-ft).



4. Install the support bearing bracket attaching bolts and the driveshaft angle spacers. Tighten the attaching bolts to 18 to 23 N·m (13 to 17 lb-ft).

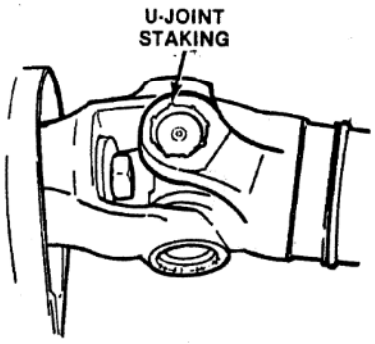


5. Lower the vehicle.

DISASSEMBLY AND ASSEMBLY

UNIVERSAL JOINTS

Because the yoke lugs are staked to hold the bearings in position, the universal joints are not serviceable. If a U-joint is damaged or worn, replace the driveshaft assembly.



SUPPORT BEARING

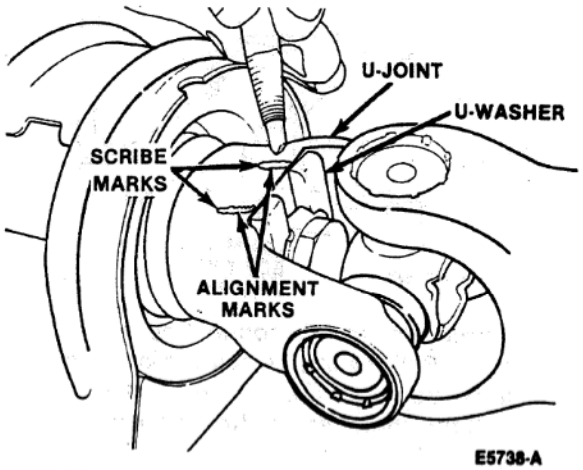
SPECIAL SERVICE TOOLS REQUIRED:

Differential Side Bearing Puller	T77F-4220-B1
Step Plate	T77F-4220-B2
Front Cover Aligner	T74P-6019-B
Step Plate	D80L-630-4

Disassembly

1. For assembly reference, scribe alignment marks on the driveshafts and U-washer.

   These components must be installed in their original positions during assembly.

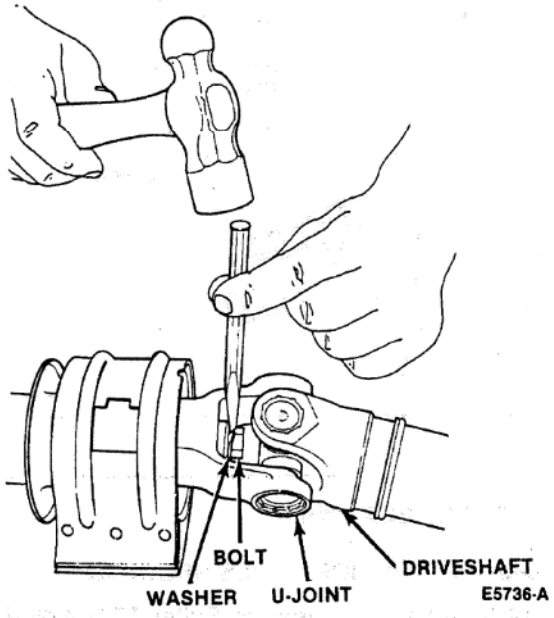


DISASSEMBLY AND ASSEMBLY

SUPPORT BEARING

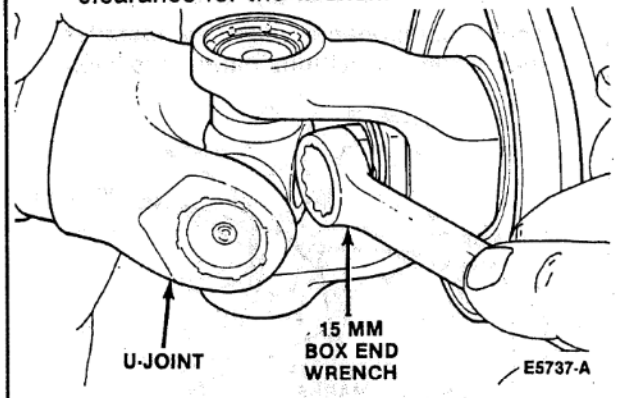
Disassembly (Continued)

2. Flatten the edge of the driveshaft connecting bolt lock washer.



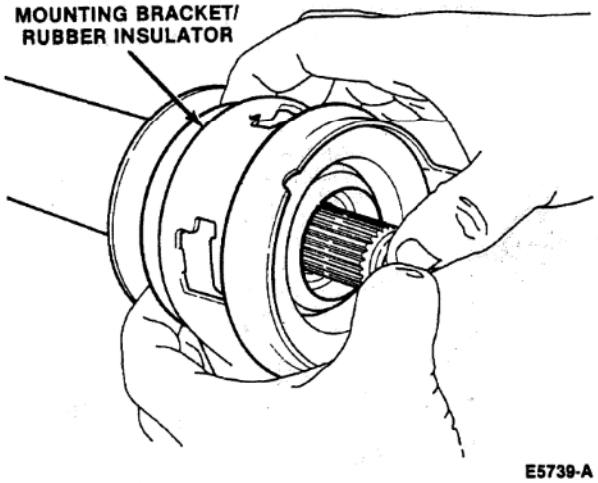
3. Using a 15 mm box end wrench, loosen the bolt attaching the two driveshafts and remove the U-washer.

   Flex the U-joint, as necessary, to provide clearance for the wrench.

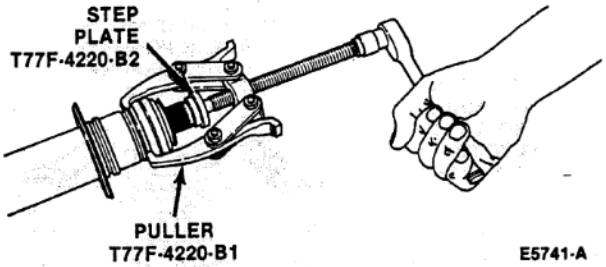


4. Thread driveshaft connecting bolt out by hand. Pull the shafts apart to provide clearance between the bolt head and U-joint. Pull the shafts apart after removing the bolt and lock washer.

5. Pull the mounting bracket and rubber insulator from the support bearing as an assembly.



6. Using Puller T77F-4220-B1 and Step Plate T77F-4220-B2, or equivalent, remove the support bearing and protective caps as an assembly.



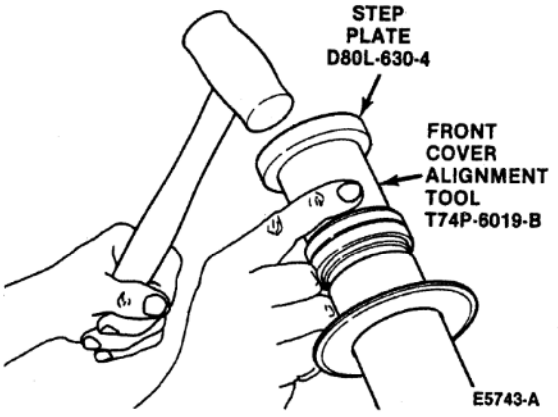
DISASSEMBLY AND ASSEMBLY

SUPPORT BEARING

Assembly

1. Pack the cavities between the support bearing and protective caps with lubricant CIAZ-19590-B, C, D, or E, or equivalent.

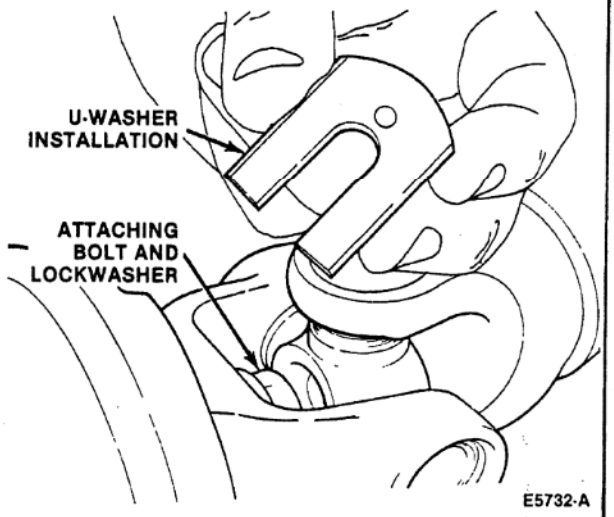
2. Be sure the red sealing disc on the bearing faces the splined end of the driveshaft and install the support bearing using Front Cover Alignment Tool T74P-6019-B and Step Plate D80L-630-4, or equivalents.



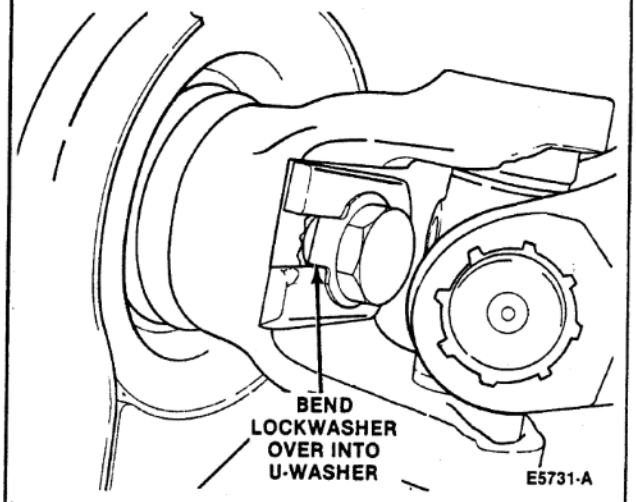
3. Push the mounting bracket and rubber over the support bearing.

4. Align the reference marks made during disassembly and push the driveshafts together. Leave enough clearance to allow installation of the connecting bolt.

5. Install the lockwasher, attaching bolt and U-washer.



NOTE: Be sure the lockwasher tab and U-washer are properly aligned before installing the bolt.



6. Tighten the driveshaft connecting bolt and bend over the lockwasher.

SECTION 15-70 HALFSHAFTS

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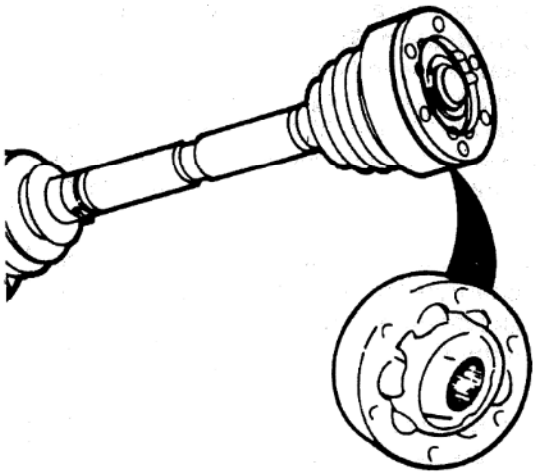
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Wheel Stub Shaft 3
Axle Stub Shaft 5

DISASSEMBLY AND ASSEMBLY

Halfshaft 5



H4205-A

DESCRIPTION

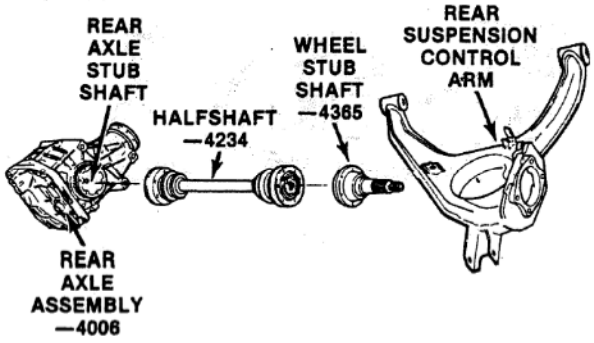
GENERAL INFORMATION

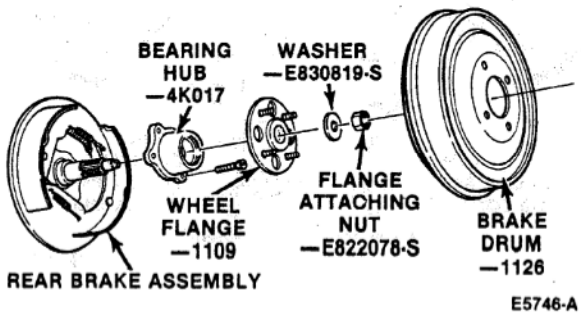
The halfshafts are the connecting links between the rear axle and the rear wheels. The inboard end of each halfshaft is attached to the axle stub shafts. The outboard ends of the halfshafts are attached to the rear wheel flange stub shafts. The halfshafts rotate and drive the rear wheels when engine torque flowing through the driveshaft to the rear axle causes rotation of the differential side gears.

Because the XR4Ti features independent rear suspension, the halfshafts must have a built-in flexibility. As the suspension moves up and down in response to road conditions, the halfshafts continuously rotate through changing angles. Constant velocity (CV), joints at the ends of the halfshafts provide the flexibility needed to compensate for suspension movement.

The CV joint consists of an inner race, cage and six ball bearings inside a housing, which also forms the bearing outer race.

NOTE: The halfshafts are of unequal length. The right side halfshaft is longer than the left side. When the halfshafts are removed, care must be taken to ensure that the halfshaft installed is the correct length for each side of the vehicle.





E5746-A

DESCRIPTION

GENERAL INFORMATION

The CV joints are lubricated with a special long-life CV joint grease and therefore do not require periodic lubrication. The CV joint boots, however, should be periodically inspected for damage. If the boot is damaged or shows signs of grease leakage, it should be replaced as soon as possible. Continued operation can result in CV joint failure due to contamination or loss of lubricant.

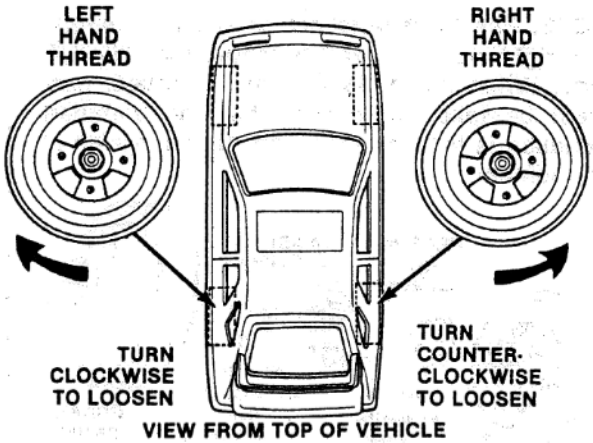
The inner and outer stub shafts are attached to the CV joint housing with six allen head bolts. This arrangement allows removal of the halfshaft without disturbing the rear brakes or rear axle.

The inner stub shafts enter the rear axle side gears and are held in position by selective-fit C-clips on the ends of the shafts.

The outer stub shafts enter the rear bearing hub through the back of the rear brake backing plate. The wheel flange is splined to the end of the shaft and is held in position with a lock nut.

The wheel flange attaching nuts are left- and right-hand threaded with a nylock insert for torque retention.

NOTE: The wheel flange attaching nuts are left- and right-hand threaded. The right-hand thread is located on the right side of the vehicle. The left-hand thread is located on the left side of the vehicle.



HALFSHAFT HANDLING

Exercise reasonable care during halfshaft removal and installation, and during the various component disassembly and assembly procedures as outlined in this section.

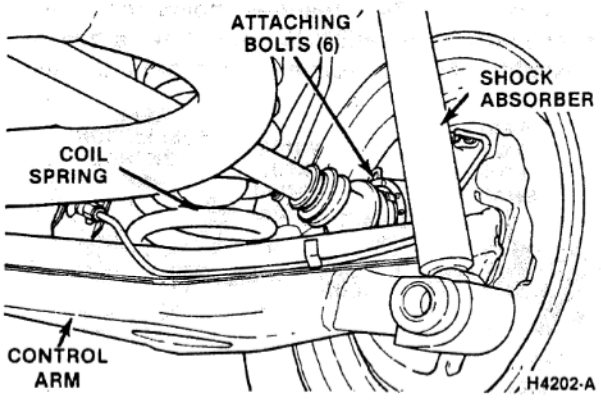
- Be careful not to damage machined surfaces and splines.
- Do not allow CV joint boots to come into contact with sharp edges or hot exhaust system components.
- Do not drop assembled halfshafts, as the impact may cut the CV joint boots from the inside without external evidence of damage.
- Do not use the halfshaft assembly as a lever arm to position other underbody components.
- Ensure internal CV joint cleanliness and proper grease refill when boot is replaced.

REMOVAL AND INSTALLATION

HALFSHAFT

Removal

1. Be sure the transmission is in neutral.
2. Be sure the parking brake is in the fully released position.
3. Raise the vehicle with the rear wheels hanging free.
4. Remove the bolts attaching the halfshaft to the wheel stub shaft. Turn the driveshaft as necessary to bring the bolts into an accessible position.

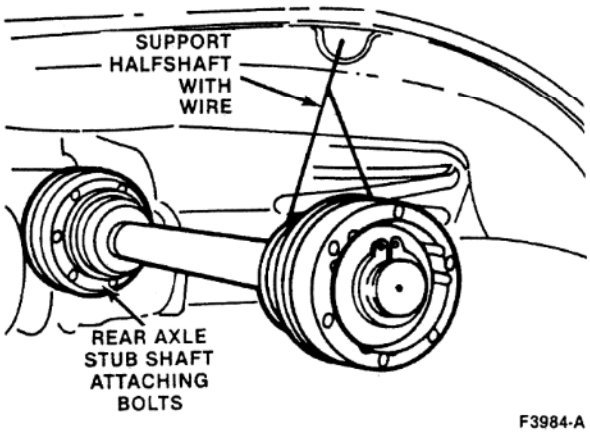


REMOVAL AND INSTALLATION

HALFSHAFT

Removal (Continued)

5. To prevent damage to the CV joints, hang the halfshaft from the floor of the vehicle.



CAUTION: Failure to hang the halfshaft from the vehicle floor may cause damage to the CV joints.

6. Remove the bolts attaching the halfshaft to the rear axle stub shaft and remove the halfshaft.

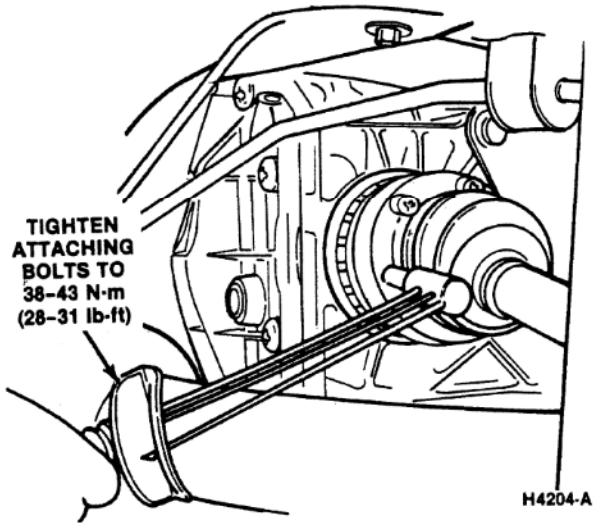
Installation

NOTE: The halfshafts are different lengths and must be installed on the correct side of the vehicle. The longer shaft is installed on the right side of the vehicle.

1. Pack the CV joints with grease C1AZ-19590-B, C, D, or E, or equivalent.
2. Hang the halfshaft from the floor of the vehicle.

CAUTION: Failure to hang the halfshaft from the vehicle floor may cause damage to the CV joints.

3. Position the halfshaft to the axle stub shaft and install the attaching bolts.
4. Release the halfshaft from the vehicle floor. Position it to the wheel stub shaft and install the attaching bolts.
5. Tighten the attaching bolts to 38 to 43 N·m (28 to 31 lb-ft).

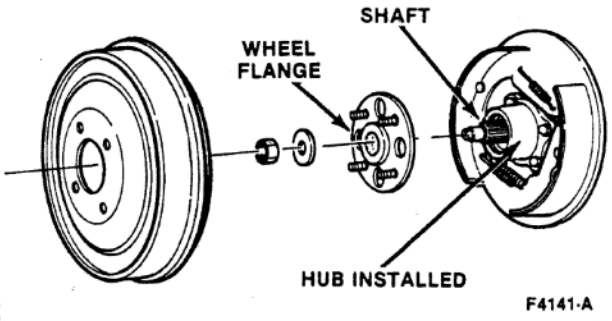


6. Lower the vehicle.

WHEEL STUB SHAFT

Removal

1. Remove the wheel drive flange. If necessary, refer to Section 11-15.



2. Be sure the transmission is in neutral.
3. Raise the vehicle with the suspension hanging free.

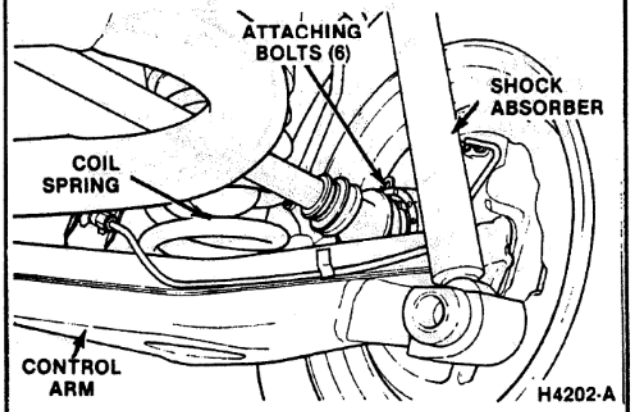
REMOVAL AND INSTALLATION

WHEEL STUB SHAFT

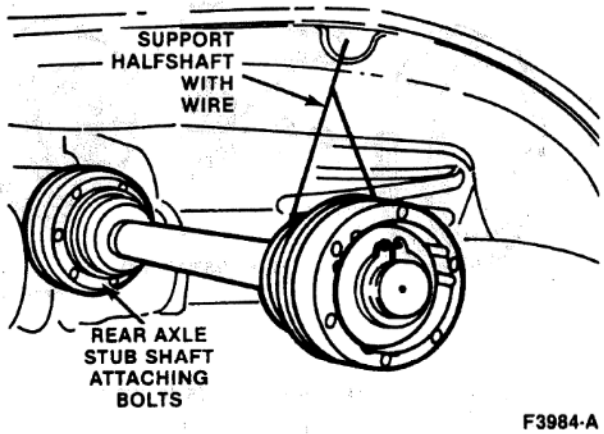
Removal (Continued)

4. Remove the bolts attaching the halfshaft to the wheel stub shaft.

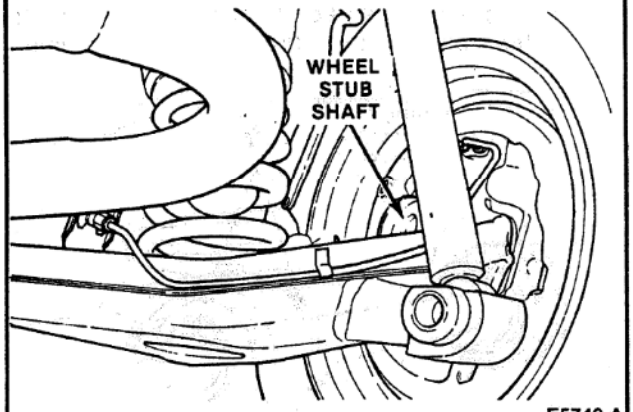
   Turn the driveshaft as necessary to bring the bolts into an accessible position.



CAUTION: To prevent damage to the CV joints, hang the halfshaft from the floor of the vehicle.

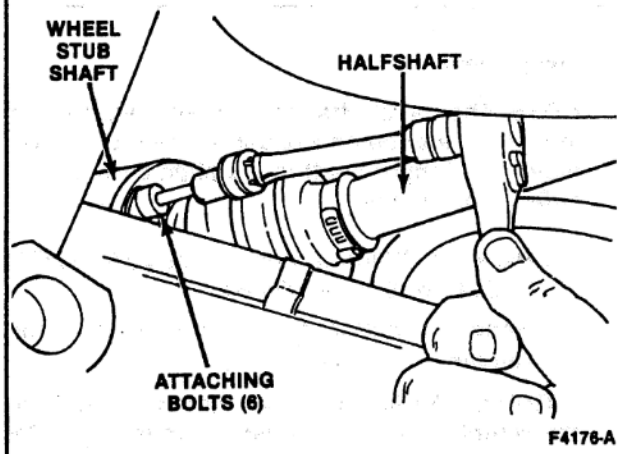


5. From under the vehicle, pull the wheel stub shaft out of the rear bearing hub.



Installation

1. Install the wheel stub shaft.
2. Position the halfshaft and install the attaching bolts. Tighten the bolts to 38 to 43 N·m (28 to 31 lb-ft).

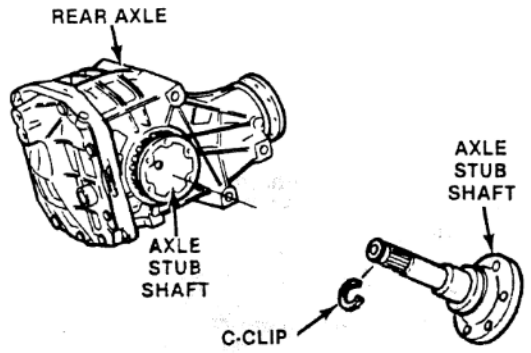


3. Install the wheel drive flange. If necessary, refer to Section 11-15.

REMOVAL AND INSTALLATION

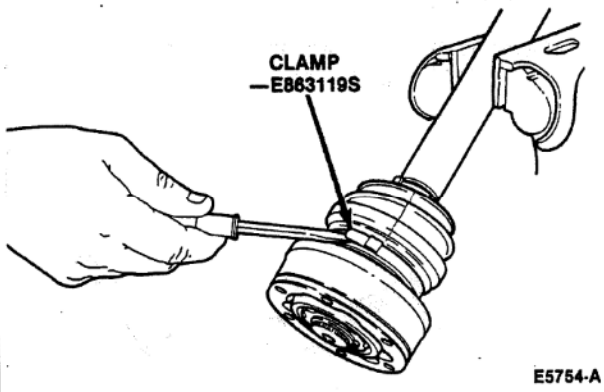
AXLE STUB SHAFT

The axle stub shafts are held in position by selective C-clips installed on the end of the shafts. The clips are located in the rear axle and rest against the differential side gears. The clips can be removed only after removal of the rear axle cover. If necessary, refer to Section 15-03.



F4142-A

3. Break and remove the boot clamps.



E5754-A

4. Peel the boot away from the joint and slide it along the shaft.

DISASSEMBLY AND ASSEMBLY

HALFSHAFT

Disassembly

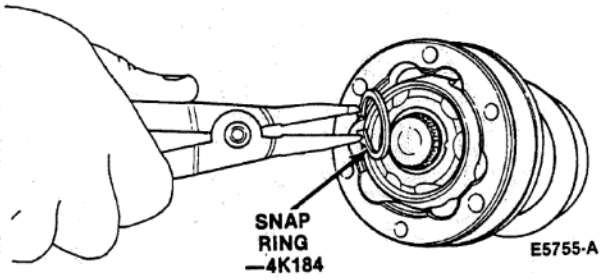
SPECIAL SERVICE TOOLS REQUIRED:

Puller	D81L-1002-A
Keystone Clamp Pliers	T63P-9171-A

CAUTION: Protective vise jaw caps must be used whenever a machined or finished surface is clamped in a vise.

1. Remove the halfshaft from the vehicle. If necessary, refer to the procedure in this section.
2. Clamp the halfshaft in a vise equipped with protective jaw caps.

5. Remove the snap ring from the end of the shaft.



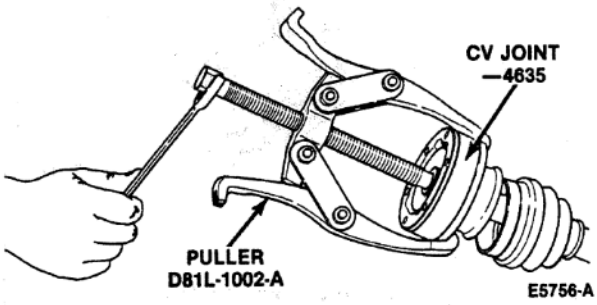
E5755-A

DISASSEMBLY AND ASSEMBLY

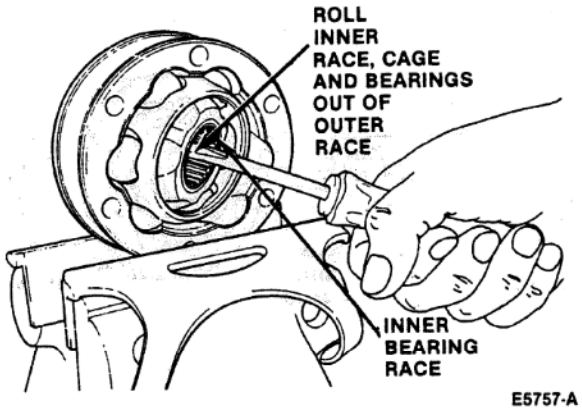
HALFSHAFT

Disassembly (Continued)

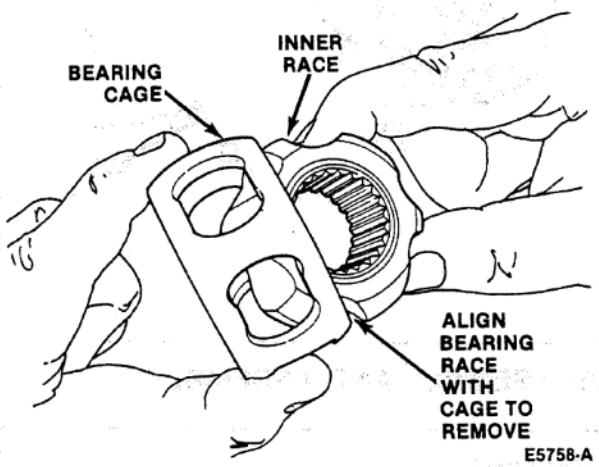
6. Remove the CV joint from the shaft, using puller D81L-1002-A or equivalent.



7. Clamp the CV joint in a vise equipped with protective jaw caps.
8. Using a large screwdriver, roll the inner race and ball cage out of the outer race.



9. The balls can be removed from the cage by prying with a small screwdriver.
10. To remove the inner race from the cage, align one of the bearing races with the cage and then roll the race out of the cage.



DISASSEMBLY AND ASSEMBLY

HALFSHAFT
COMPONENT INSPECTION CHART

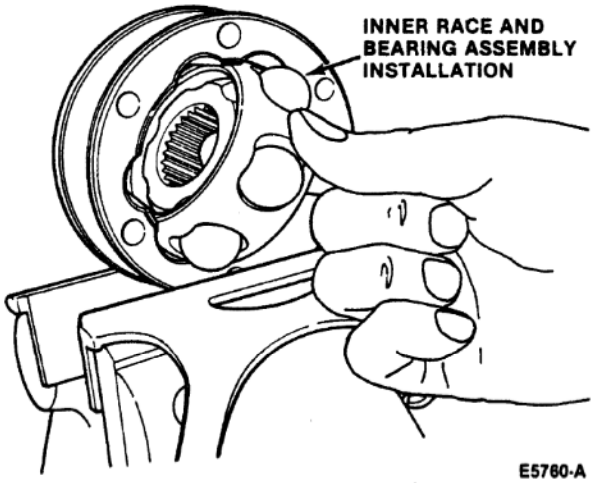
COMPONENT	CHECK FOR
DUST BOOTS	• Cuts or tears • Abrasion damage • Brittleness
CV JOINT	• Worn or scored bearing surfaces • Damaged or loose bearings • Cracks in bearing surfaces
CENTER SHAFTS	• Twisted or bent • Damaged splines • Damaged snap ring groove

CE773-A

HALFSHAFT

Assembly

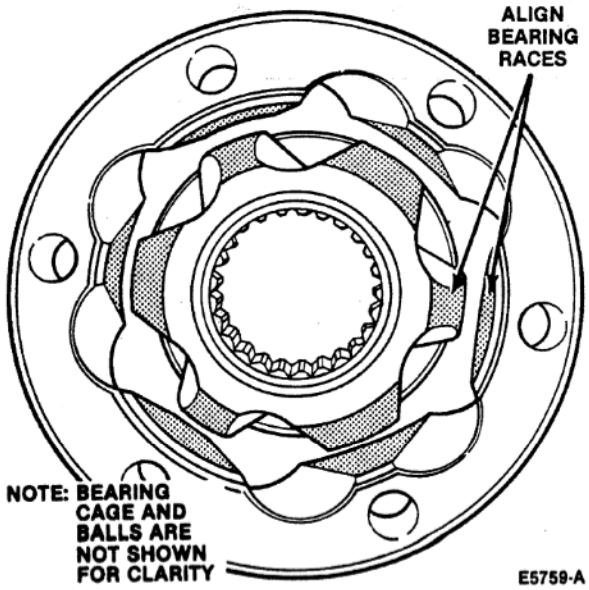
1. Assemble the inner race, cage and ball bearings.
2. Install the assembly in the housing with two of the ball bearings entering the two races shown.



E5760-A

3. Pull upward on the inner race and roll the assembly into position.

NOTE: The narrow ends of the inner races must be aligned with the wide ends of the housing races before the race, cage and ball assembly can enter the housing.



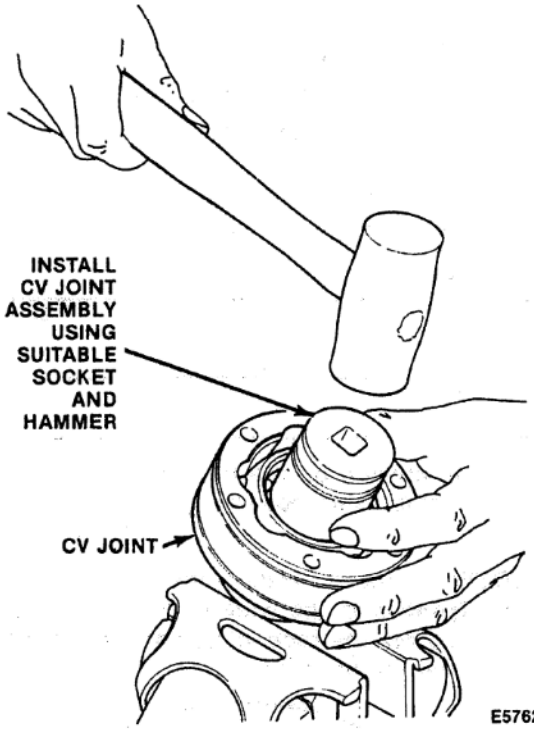
E5759-A

DISASSEMBLY AND ASSEMBLY

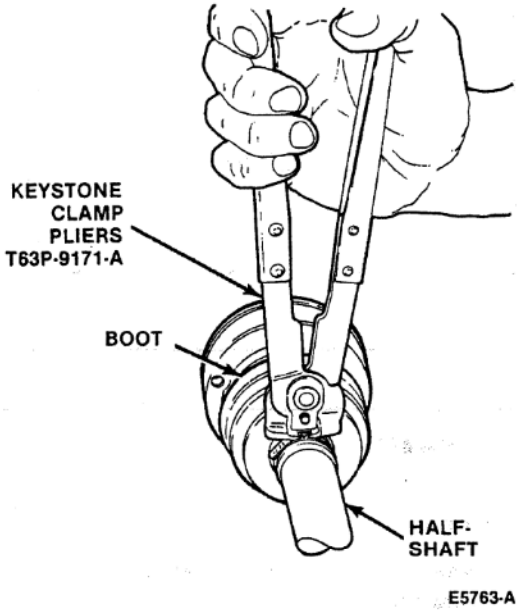
HALFSHAFT

Assembly (Continued)

4. Pack the CV joint with lubricant C1AZ-19590-B, C, D, or E.
5. Install the CV joint on the shaft. A hammer and socket can be used to install the joint.



6. Install the snap ring.
7. Position the boot and install new clamps, using Keystone Clamp Pliers T63P-9171-A, or equivalent.



GROUP 15 Specifications

REAR AXLE RATIOS:

- Manual transmission—3.64:1
- Automatic transmission—3.36:1

REAR AXLE DESIGN:

- 7.5 inch
- Open type
- Aluminum case
- Pinion depth controlled by shim under inner bearing cup during manufacture. Placed between inner bearing and pinion head for servic
- Pinion bearing preloaded with collapsible spacer
- Backlash adjusted using threaded side bearing carriers

TORQUE SPECIFICATIONS

Item	N·m	lb-ft
Rear mount to axle cover	50-55	37-41
Rear mount to body	50-67	37-50
Axle to crossmember	70-90	51-66
Half shaft to stub shaft	38-43	28-31
Ring gear to differential case	75-90	55-66
Pinion flange to pinion shaft	130-150	95-110
Bearing carrier lock plates to case	19-25	14-18
Cover to case	45-60	33-44

MANUAL TRANSMISSION

GROUP 16 (7000)

TITLE SECTION PAGE NO. TITLE SECTION PAGE NO.

CLUTCH AND TRANSMISSION DIAGNOSIS 16-01

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- Clutch Chatter (Shudder) 10
- Clutch Drag 10
- Clutch Pedal Pulsation 10
- Clutch-related Vibrations 11
- Clutch-related Noises 11
- Flywheel Housing Alignment Check 12
- Flywheel Runout Check 13
- Leak Check 14

CLUTCH 16-02

DESCRIPTION 1

REMOVAL AND INSTALLATION

- Clutch Release Lever and Bearing 2
- Clutch Pressure Plate and Disc 3
- Crankshaft Pilot Bearing 5
- Engine Flywheel 6
- Flywheel Housing Dowels 6
- Transmission Front Bearing Retainer/Seal 7
- Clutch Pedal/Self-Adjuster 9
- Clutch Cable 12

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FIVE-SPEED MANUAL TRANSMISSION 16-33

DESCRIPTION 1

POWERFLOW

- Neutral/Component Identification 2
- First Gear 3
- Second Gear 3
- Third Gear 4
- Fourth Gear 4
- Reverse Gear 5
- Fifth Gear 5
- Overdrive 6

REMOVAL AND INSTALLATION

- Transmission 6
- Extension Housing Seal 8
- Extension Housing Bushing 8
- Shift Lever and Boot 9

DISASSEMBLY AND ASSEMBLY 10

FLUID LEVEL CHECK 48

GROUP 16

SPECIFICATIONS 1

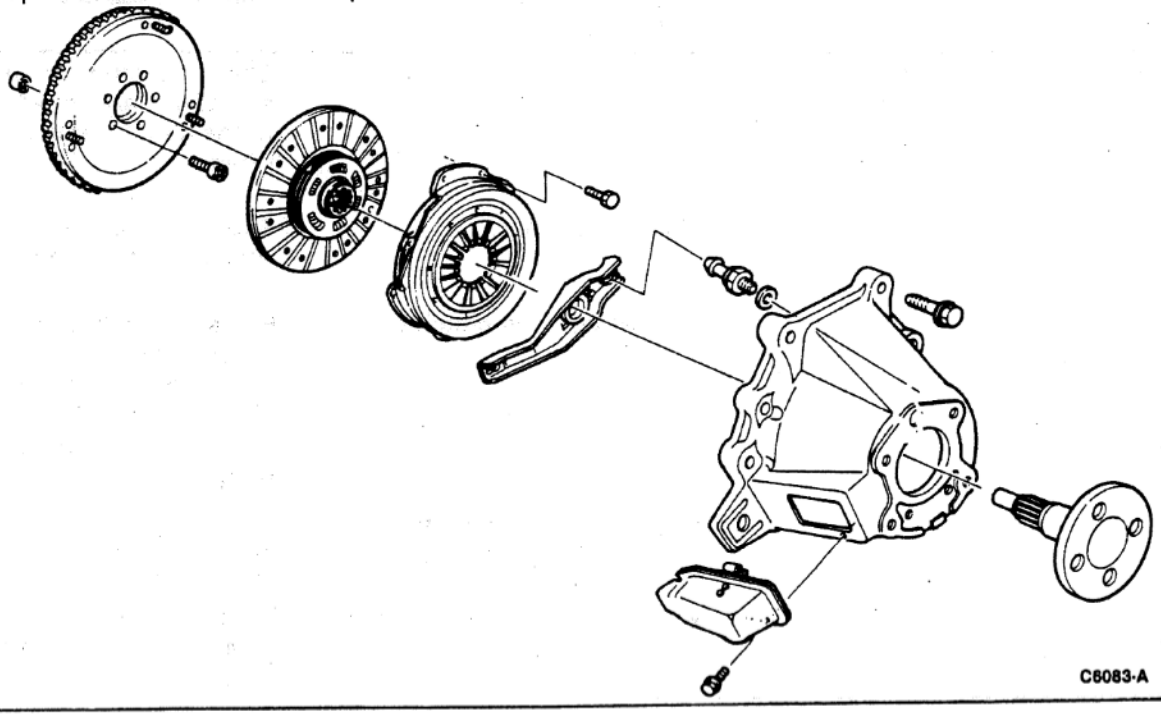
SECTION 16-01 CLUTCH AND TRANSMISSION DIAGNOSIS

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GENERAL INFORMATION

Before referring to the troubleshooting charts in this section, try to determine whether the cause of the problem is the transmission or the clutch. Problems related to the clutch such as slippage and drag are described in the Diagnostic Procedures part of this section. Once the problem is narrowed to either the clutch, transmission, clutch cable or leakage, refer to the appropriate chart for the description that best fits the problem. Use the Possible Cause column to isolate the problem to a specific component and then use the Corrective Action column to determine the appropriate repair. In some cases, this column will refer to procedures either in this section or other sections in the Shop Manual. After making a repair, always road test the vehicle to confirm the diagnosis and repair.



C6083-A

TROUBLESHOOTING CHARTS

CLUTCH

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Clutch chatter or shudder (refer to the Diagnostic Procedure in this section that describes clutch chatter or shudder.)	Grease or oil on clutch disc	Replace clutch disc. Repair cause of leak. If necessary, refer to Section 16-02.
	Broken or weak pressure plate spring	Replace pressure plate. If necessary, refer to Section 16-02.
	Broken or weak clutch torsion springs	Replace clutch disc. If necessary, refer to Section 16-02.
	Scored, heat-checked or warped pressure plate or flywheel	Replace pressure plate or flywheel. If necessary, refer to Section 16-02.
	Worn transmission input shaft bearing	Replace bearing. If necessary, refer to Section 16-02.
	Worn input shaft splines	Replace input shaft. If necessary, refer to Section 16-33.
	Loose or broken engine or transmission mounts	Tighten or replace.
	Loose or missing transmission or bell housing bolts	Tighten or replace.
Clutch slippage (refer to the Diagnostic Procedure in this section that describes clutch slippage)	Improper clutch cable adjustment	Check operation of self-adjusting cable quadrant. Refer to the clutch cable Diagnostic Chart.
	Worn clutch disc	Replace clutch disc. If necessary, refer to Section 16-02.
	Grease or oil on clutch disc	Replace clutch disc and repair cause of leak. If necessary, refer to Section 16-02.
	Glazed clutch disc	Replace clutch disc. If necessary, refer to Section 16-02.
	Heat-checked or warped pressure plate or flywheel	Replace pressure plate or flywheel. If necessary, refer to Section 16-02.
	Worn or broken release bearing	Replace release bearing. If necessary, refer to Section 16-02.

TROUBLESHOOTING CHARTS

CLUTCH (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Clutch drag (refer to the Diagnostic Procedure in this section that describes clutch drag)	Improper clutch cable adjustment	Check operation of self-adjusting cable quadrant. Refer to the clutch cable Diagnostic Chart.
	Warped clutch disc, pressure plate or flywheel	Replace as necessary. If necessary, refer to Section 16-02.
	Bent or broken pressure plate fingers or spring	Replace pressure plate. If necessary, refer to Section 16-02.
	Broken clutch disc cushion spring	Replace clutch disc. If necessary, refer to Section 16-02.
	Worn input shaft splines	Replace input shaft. If necessary, refer to Section 16-33.
	Clutch housing not properly aligned	Check clutch housing alignment. If necessary, refer to the Diagnostic Procedure in this section.
Clutch pedal pulsation (refer to the Diagnostic Procedure in this section that describes clutch pedal pulsation)	Uneven or bent pressure plate fingers	Replace pressure plate. If necessary, refer to Section 16-02.
	Worn, grooved release bearing	Replace release bearing. If necessary, refer to Section 16-02.
	Bent release lever	Replace release lever. If necessary, refer to Section 16-02.
	Loose pressure plate mounting bolts	Tighten bolts.

TROUBLESHOOTING CHARTS

CLUTCH (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Clutch vibration (refer to the Diagnostic Procedure in this section that describes clutch vibration)	Loose transmission or flywheel housing bolts	Tighten bolts.
	Damaged engine mounts	Replace mounts.
	Worn or broken transmission mount	Replace transmission mount.
	Pressure plate or flywheel out of balance	Replace pressure plate or flywheel. If necessary, refer to Section 16-02.
	Loose flywheel mounting bolts	Tighten bolts.
	Excessive flywheel lateral runout	Check flywheel runout. If necessary, refer to the Diagnostic Procedure in this section.
Clutch noise (refer to the Diagnostic Procedure in this section that describes clutch-related noises)	Worn clutch release bearing (grinding noise when pedal is depressed)	Replace release bearing. If necessary, refer to Section 16-02.
	Worn clutch shaft or countershaft bearings (grinding noise with clutch engaged)	Disassemble transmission and replace worn bearings. If necessary, refer to Section 16-33.
	Worn pilot bearing (squealing noise with partial clutch engagement)	Replace pilot bearing. If necessary, refer to Section 16-02.

C6084-A

TROUBLESHOOTING CHARTS

TRANSMISSION

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Hard shifting into gear	Shift shaft or interlocks binding	Free up shift assembly.
	Clutch cable not adjusted properly	Check self-adjusting cable quadrant. Refer to the clutch cable Diagnostic Chart.
	Bent or worn shifter fork	Replace shifter fork.
	Worn shift shaft	Replace shift shaft. If necessary, refer to Section 16-33.
	Gears or synchronizer tight on shaft or splines	Replace worn parts. If necessary, refer to Section 16-33.
	Worn synchronizer blocker rings or springs	Replace worn synchronizer parts. If necessary, refer to Section 16-33.
	Worn or stripped gear teeth	Replace gear. If necessary, refer to Section 16-33.
	Input shaft or pilot bearing binding	Replace pilot bearing or input shaft. If necessary, refer to Section 16-02 or 16-33.
	Low fluid level	Fill to proper level. If necessary, refer to Section 16-33.
	Improper fluid used (particularly cold)	Refill with specified semi-synthetic fluid.
Transmission sticks in gear	Shift shaft or interlocks binding	Free up shift assembly.
	Shift detents sticking	Free up shift detent.
	Clutch not releasing	Repair clutch cable. Refer to the clutch cable Diagnostic Chart.
	Synchronizer unit binding	Replace binding synchronizer. If necessary, refer to Section 16-33.
	Low fluid level	Fill to proper level. If necessary, refer to Section 16-33.

TROUBLESHOOTING CHARTS

TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Transmission slips out of gear	Weak detent spring tension	Replace spring. If necessary, refer to Section 16-33.
	Worn input, output bearings	Replace bearings. If necessary, refer to Section 16-33.
	Worn pilot bearing	Replace pilot bearing. If necessary, refer to Section 16-02.
	Excessive shaft or gear endplay	Replace worn thrust washers. If necessary, refer to Section 16-33.
	Worn synchronizer	Replace synchronizer.
	Loose or broken input shaft retainer	Replace input shaft retainer. If necessary, refer to Section 16-33.
	Loose transmission or flywheel housing	Tighten mounting bolts.
	Misaligned transmission	Check transmission alignment. If necessary, refer to the Diagnostic Procedure in this section.
Gear clash in shifting	Worn synchronizer	Replace synchronizer. If necessary, refer to Section 16-33.
	Clutch dragging	Repair clutch. If necessary, refer to Section 16-02.
	Pilot bearing or input shaft binding	Replace pilot bearing or input shaft. If necessary, refer to Section 16-02.
	High engine idle speed	Adjust engine idle speed. If necessary, refer to Section 21-01.
	Low fluid level or improper fluid	Fill with correct fluid to proper level. If necessary, refer to Section 16-33.

TROUBLESHOOTING CHARTS

TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Transmission noisy in gear	Defective clutch disc	Replace clutch disc. If necessary, refer to Section 16-02.
	Excessive clearance between gear(s) and mainshaft	Replace worn gears or shaft. If necessary, refer to Section 16-33.
	Worn or defective bearings	Replace bearings. If necessary, refer to Section 16-33.
	Broken gear tooth	Replace gear. If necessary, refer to Section 16-33.
	Worn speedometer pinion gear	Replace pinion gear. If necessary, refer to Section 16-33.
	Worn synchronizer	Replace synchronizer. If necessary, refer to Section 16-33.
	Worn pilot bearing	Replace bearing. If necessary, refer to Section 16-02.
	Low fluid level	Fill to proper level.
	Transmission misaligned	Check transmission alignment. If necessary, refer to the Diagnostic Procedure in this section.
	Worn countershaft bearings or thrust washers	Replace bearings or thrust washers. If necessary, refer to Section 16-33.
Transmission noisy in neutral	Worn input shaft bearing	Replace bearing. If necessary, refer to Section 16-33.
	Broken or worn gear	Replace gear. If necessary, refer to Section 16-33.

TROUBLESHOOTING CHARTS

TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
No power through transmission	Clutch not engaging	Repair clutch. Refer to the clutch cable Diagnostic Chart.
	Striped gear teeth	Replace gear. If necessary, refer to Section 16-33.
	Loose or broken shifter fork	Replace shifter fork. If necessary, refer to Section 16-33.
	Broken input or output shaft	Replace shaft. If necessary, refer to Section 16-33.

C6085-A

CLUTCH CABLE

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Gears clash when shifting	Weak or missing self-adjuster pawl spring	Replace pawl spring. If necessary, refer to Section 16-02.
	Incorrect clutch adjustment	Check operations of self-adjuster and cable condition.
Clutch does not disengage	Self-adjuster pawl or quadrant binding or stripped	Clean and lubricate pawl and/or quadrant. Replace if necessary. If necessary, refer to Section 16-02.
Pedal makes a ratcheting noise when depressed	Teeth stripped on self-adjuster quadrant or pawl	Replace quadrant or pawl. If necessary, refer to Section 16-02.
Pedal falls to floor with no effort	Broken clutch release cable	Replace cable. If necessary, refer to Section 16-02.
	Self-adjuster pawl not engaging quadrant	Replace pawl spring. If necessary, refer to Section 16-02.
Excessive pedal effort (over 45 lb)	Damaged or kinked clutch release cable	Replace cable. If necessary, refer to Section 16-02.
	Clutch pedal binding	Disconnect cable at quadrant and recheck pedal effort. Free up as necessary. If necessary, refer to Section 16-02.

TROUBLESHOOTING CHARTS

CLUTCH CABLE (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Excessive pedal effort (Cont'd.)	Binding clutch release lever	Repair or replace. If necessary, refer to Section 16-02.
	Damaged clutch disc or pressure plate	Repair as necessary. If necessary, refer to Section 16-02.

NOTE: If above actions do not repair the problem, see Clutch Diagnosis Chart.

C6086-A

OIL LEAKAGE

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Oil leaks (Refer to Leak Check Diagnostic Procedure in this Section for methods used to determine leak sources.)	Incorrect fluid or fluid level too high, causing foaming	Fill with proper fluid to proper level. If necessary, refer to Section 16-33.
	Leaking gaskets	Replace gaskets. If necessary, refer to Section 16-33.
	Damaged oil seals	Replace oil seals. If necessary, refer to Section 16-33.
	Damaged oil slinger	Replace oil slinger. If necessary refer to Section 16-33.
	Loose filler plug	Tighten filler plug.
	Speedometer pinion seals leaking	Replace seals.
	Cracked case or extension housing	Replace case or extension housing. If necessary, refer to Section 16-33.
	Worn extension housing seal or bushing	Replace seal or bushing. If necessary, refer to Section 16-33.

C6087-A

DIAGNOSTIC PROCEDURES

CLUTCH SLIPPAGE

Clutch slippage can be described as a condition in which the engine over-speeds but does not generate a torque increase to the rear wheels. This is most noticeable during rapid acceleration from a standing start. Slippage occurs when the clutch disc is not gripped firmly between the flywheel and pressure plate. When slippage occurs, it generates a considerable amount of heat which, if not diagnosed and repaired immediately, will warp, groove, score or crack the pressure plate and flywheel.

To check for a slipping clutch:

1. Block the wheels and set parking brake.
2. Start engine, shift into fourth gear and increase engine speed to 2,000 rpm.
3. Slowly release clutch pedal. If engine stalls within five seconds, clutch is OK. If engine does not stall, clutch is slipping.

CLUTCH DRAG

Clutch drag is best described as a condition in which the driven plate (clutch disc) is still being driven with the clutch disengaged. This can cause gear clash when shifting.

To check for clutch drag:

1. Start engine, depress clutch pedal and shift into first gear.
2. With clutch pedal still depressed, shift transmission into neutral.
3. Wait five seconds and shift into reverse. Shift should be smooth with no gear clash. If gears clash, the clutch is dragging; refer to Clutch Diagnosis Chart.

CLUTCH CHATTER OR SHUDDER

Clutch chatter is best described as a shuddering of the vehicle when the clutch is first engaged. Chatter is usually an internal problem in the clutch assembly which in most cases cannot be repaired with linkage adjustments.

To check for chatter:

1. Start engine, depress clutch pedal and shift into first gear.
2. Raise engine speed to 1200 to 1500 rpm. Slowly release clutch pedal and observe clutch operation.
3. Shift into reverse and repeat Step 2. If vehicle shudders, a chatter condition is present.

Items that could also cause clutch chatter are loose engine or transmission mounts, loose transmission or flywheel housing mounting bolts, or oil leakage to clutch assembly. If clutch clatter is evident at low speed with the clutch fully engaged, the problem is more likely to be engine/transmission mounts or loose bolts. If no problems are found in these areas, refer to Clutch Diagnosis Chart.

CLUTCH PEDAL PULSATION

Clutch pedal pulsation is a rapid up-and-down movement of the pedal when the pedal is partially or fully depressed and the release bearing is in contact with the release fingers.

To check for pedal pulsation:

1. With the transmission in neutral, start engine and slowly depress clutch pedal until all free-play is removed.
2. Continue to slowly depress pedal while checking for pulsation.

   Pedal should pulsate very slightly or not at all. If heavy pulsation occurs, refer to Clutch Diagnosis Chart.

DIAGNOSTIC PROCEDURES

CLUTCH-RELATED VIBRATIONS

Clutch-related vibrations differ from pedal pulsations in frequency and magnitude and can be felt throughout the vehicle.

Clutch vibrations usually occur at relatively high engine speed (over 1500 rpm) regardless of clutch pedal position. However, vibrations related to clutch component imbalance occur infrequently as the clutch cover and driven plate are balanced as a unit at assembly. The clutch is installed on the crankshaft/flywheel assembly and given a final fine-tune balance. Replacement of clutch components to correct vibrations should be performed only after exhausting all other possibilities.

Check clutch operation as follows:

1. Raise the vehicle on a hoist and check the engine mount interlocks for grounding. Repair as necessary.
2. Check for any other engine component (e.g., exhaust manifold, valve cover, etc.) grounding on the body or frame. If one of these components is grounded, repair as necessary and check for vibration.
3. If the vibration ceases, stop repair. If the vibration continues, lower the vehicle and proceed to next step.
4. Disconnect the accessory drive belts one at a time and check for vibration. If the vibration is corrected after removal of a drive belt, the cause of vibration is related to that accessory or that drive belt. Repair as necessary.
5. If the vibration continues, check the following areas for other possible causes of clutch-related vibrations:
   - Loose flywheel mounting bolts
   - Excessive flywheel face runout of 0.12 mm (0.005 in.) or more
   - Damaged crankshaft vibration damper
   - Clutch cover imbalance
6. To check for imbalance, remove the transmission and clutch components and support the engine securely. Operate the engine with the clutch components removed. If the vibration is no longer evident, replace the clutch components.

CLUTCH-RELATED NOISES

Throwout Bearing Noise

Throwout bearing noises can be described as whirring, grating, or grinding noises that occur when the clutch pedal is depressed (clutch disengaged).

Throwout bearing noise is corrected by replacing the bearing. If necessary, refer to Section 16-02.

Transmission Clutch Shaft or Countershaft Bearing Noise

Input shaft or countershaft bearing noises can be described as whirring, grating, or grinding noises that cease when the clutch pedal is depressed (clutch disengaged) or when the transmission is shifted into gear. These noises are most noticeable when the clutch pedal is fully released and the transmission is in Neutral.

Correction requires transmission removal and replacement of the problem bearing(s).

FLYWHEEL HOUSING ALIGNMENT CHECK

SPECIAL SERVICE TOOLS REQUIRED:

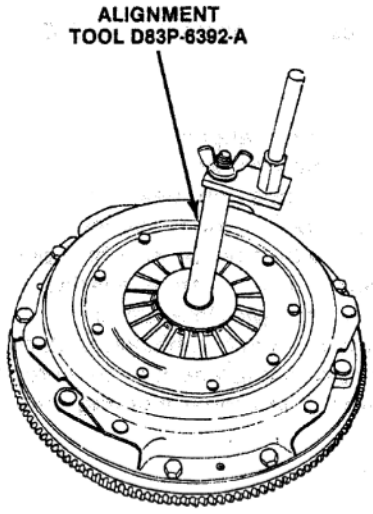
Clutch Housing Alignment Adapter	T75L-4201-B
Clutch Housing Alignment Adapter	T75L-4201-A
Dial Indicator	T00L-4201-C
Clutch Housing Alignment Tool	D83P-6392-A

Inspection and/or alignment of the flywheel housing is indicated when symptoms exist of excessive transmission gear wear, transmission jumping out of gear, driveline vibration, clutch pedal vibration or scrubby pedal feel, pilot bearing noise, release bearing noise, or excessive clutch spin time. Common complaint areas should always be checked and corrected prior to checking alignment to be sure that the basic system is in proper working order.

DIAGNOSTIC PROCEDURES

FLYWHEEL HOUSING ALIGNMENT CHECK (Continued)

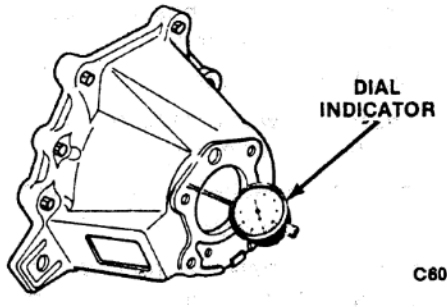
1. Remove the transmission from the vehicle. If necessary, refer to Section 16-33. With the transmission removed, remove the flywheel housing from the vehicle.
2. Inspect, clean and/or remove all nicks, burrs, paint and other foreign material from the following:
   a. Front and rear face of flywheel housing
   b. Flywheel housing bore surface
   c. Rear face of engine block
   d. Rear engine plate
   e. Flywheel and engine block dowels (missing or damaged dowels must be replaced). If necessary, refer to Section 16-02.
3. Install Alignment Tool D83P-6392-A, or equivalent, with the dial indicator post attached through the flywheel housing bore and onto the pressure plate fingers. The oblong washer is to be forward of the pressure plate fingers, while the round washer will remain on the rearward side with the tabs contacting the fingers. Tighten the nut on the end of the post assembly until the washers grip the pressure plate fingers tightly.



C4247-A

Up, down or side movement of the post assembly must not be evident during the bore and runout test procedure. If any movement is detectable, loosen the nut and rotate the post assembly to gain better mounting location on the pressure plate fingers. Otherwise, an erratic reading will result.

4. Install the rear engine plate and flywheel housing without the clutch release lever and bearing. Tighten the attaching bolts to specification.
5. To check flywheel housing face runout, install a dial indicator on the base post, using the universal bracket and short extension bar (Tool T75L-4201-B, or equivalent) provided with the alignment kit. Position the dial indicator so that the indicator button contacts a circumference just outside the transmission pilot hole. Tighten the universal clamp securely.



C6088-A

6. Push the crankshaft rearward to remove any endplay. Set the dial indicator to zero.

DIAGNOSTIC PROCEDURES (Continued)

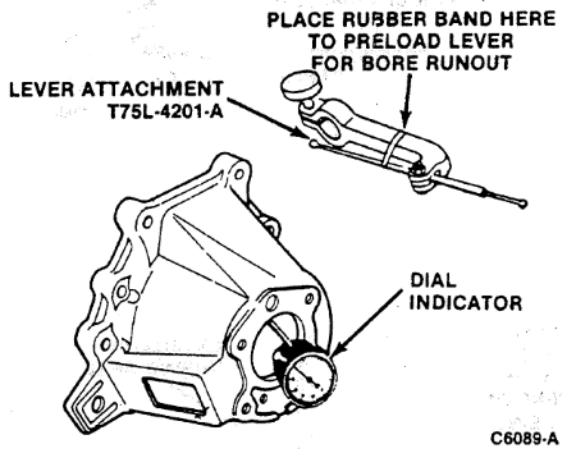
7. While holding the crankshaft in the rearward position, rotate the crankshaft through one complete revolution, using a wrench on the crankshaft pulley attaching nut. The dial indicator should return to zero after one revolution unless endplay or a loose alignment post has affected the reading.

CAUTION: Always turn the crankshaft clockwise which is the normal direction of rotation. Backward rotation may cause the timing belt to jump time, due to the arrangement of the belt tensioner.

8. During Step 7, the greatest variation between indicator readings for one revolution should be recorded. A small mirror will be necessary during this procedure to read the indicator through its complete rotation.

9. To verify the reading in Step 8, the procedure should be repeated a second time.

10. After completion of the face runout check, install the dial indicator lever attachment to the dial indicator and position the assembly to check bore runout. The rubber band shown attached to the lever must be installed as indicated, prior to installation of the lever, to preload the dial indicator for bore readings.



11. Zero the dial indicator and rotate the crankshaft through one revolution as in Step 7. Record the greatest variation between the indicator readings for the complete crankshaft revolution. The reading should be verified by repeating the procedure a second time.

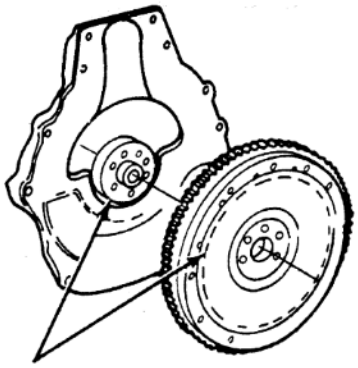
12. If the maximum variation measurements obtained in Steps 8 and 11 show that face runout exceeds .254mm (.010 in.) T.I.R. and/or the bore runout exceeds .381mm (.015 in.) T.I.R., the flywheel housing should be replaced.

Before reassembly of the transmission to the flywheel housing, the front mounting face of the transmission should be inspected and cleaned. Any nicks, burrs, paint or foreign material must be removed to be sure of alignment between these components. Welch plugs should also be checked for proper installation. If dowels on the flywheel or rear face of the engine are missing or damaged, they must be replaced. If necessary, refer to Section 16-02.

Flywheel Runout Check

Install Dial Indicator Tool 4201-C, or equivalent, so that the indicator point bears against the flywheel face. Turn the flywheel, making sure to hold it in the full forward or rearward position so that crankshaft endplay will not be indicated as flywheel runout.

If the clutch face runout exceeds specification, remove the flywheel and check for burrs between the flywheel and the face of the crankshaft mounting flange. If no burrs exist, check the runout of the crankshaft mounting flange. Replace the flywheel or machine the crankshaft flywheel mounting face sufficiently to true up the surface if the mounting flange runout exceeds specification.



DIAGNOSTIC PROCEDURES (Continued)

Leak Check

Cleaning

Remove as much oil and grease as possible from the outside of the transmission using a suitable solvent. Gasketed areas should be throughly cleaned using a spray solvent with a directional nozzle. After cleaning, dry the transmission with compressed air.

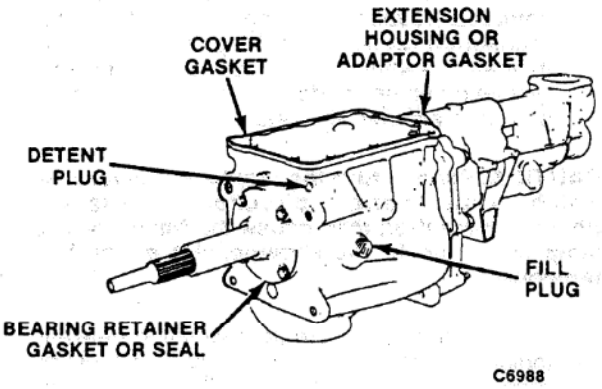
Inspection

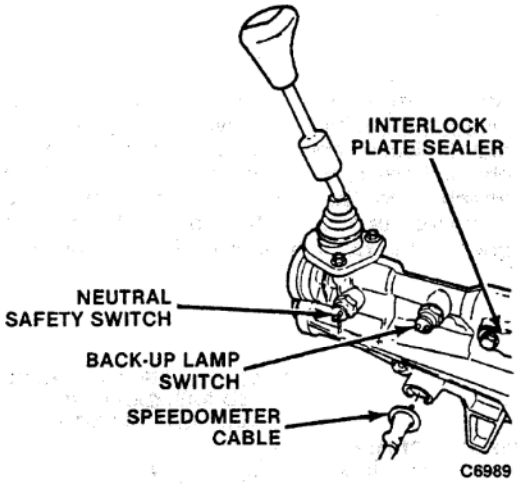
Using the procedure in Section 16-33, check the transmission fluid level and add oil, if necessary. Spray the transmission with a suitable leak detecting powder. Baby powder is a suitable substitute. Then, drive the vehicle at least ten miles, using all gear positions several times. Raise the vehicle and inspect for traces of oil in the leak detecting powder. Possible leak points are shown in the illustrations.

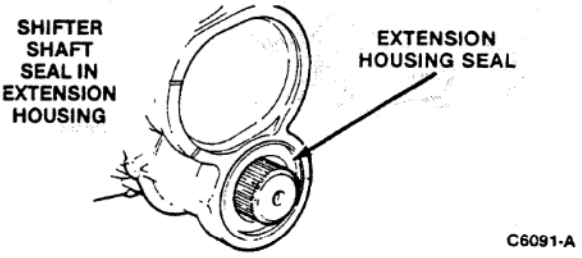
Leak Repair

If the source of the leak is a gasketed surface, remove and replace the gasket. If necessary, refer to Section 16-33. Before installing the new gasket, inspect the gasket surfaces for nicks, gouges, scratches or damage that might prevent proper sealing. If the surfaces cannot be "cleaned up," replace components as necessary.

If the leak is traced to a seal, remove and replace the seal. If necessary, refer to Section 16-33. Before installing the new seal, inspect the shaft sealing area for grooves, nicks or gouges that could damage the new seal. The seal seat should also be inspected for damage or casting defects which may cause the seal leakage. If the seat cannot be sealed or "cleaned up" replace the component.







SECTION 16-02 CLUTCH

CONTENTS

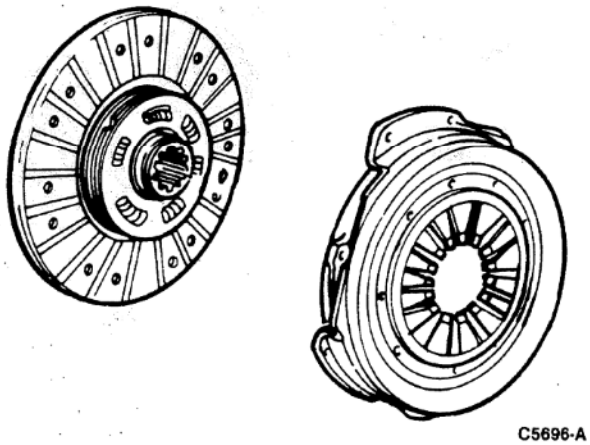
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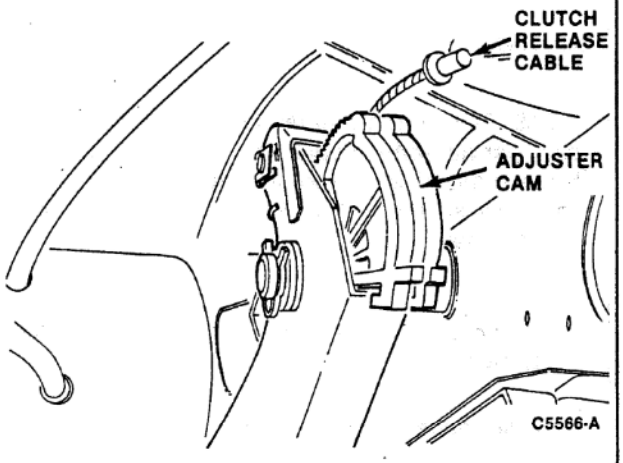


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DESCRIPTION

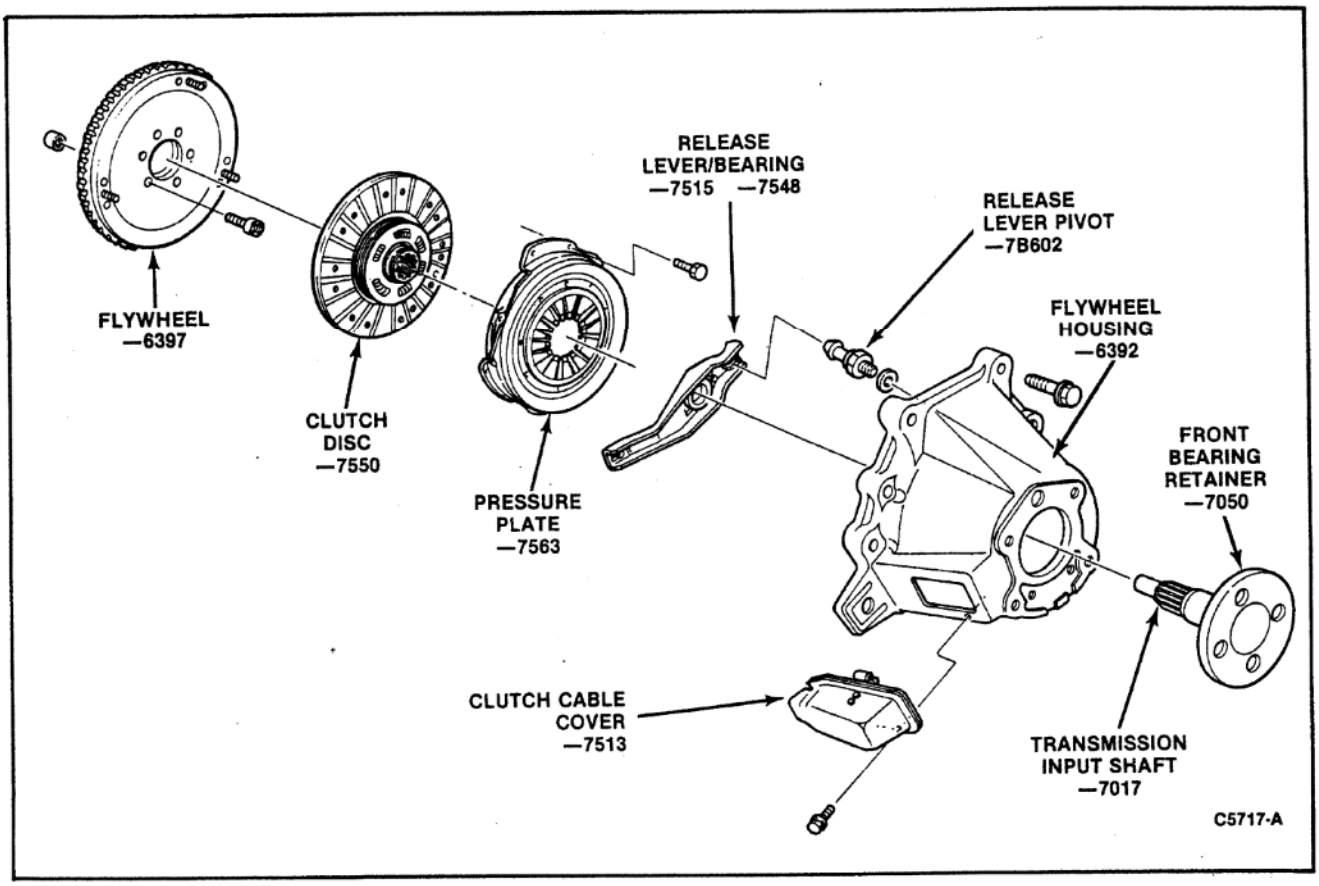
The clutch consists of three operating elements —a friction disc, pressure plate and the necessary release components. The clutch, or friction, disc is splined to the transmission input shaft and is the actual mechanical connection between the engine and transmission. The pressure plate assembly is bolted to the flywheel and consists of a cast-iron plate, diaphragm spring and cover. The release components begin at the clutch pedal and extend through a plastic-coated cable to the release lever and bearing. Except for the release cable and pedal, the clutch elements are enclosed in the flywheel housing which is bolted between the engine and transmission. The release lever extends from the release cable through the left side of the flywheel housing to a pivot ball threaded into the rear of the housing. Between the cable and pivot, the lever engages the throw-out bearing which is installed on the transmission front bearing retainer. The retainer is extended outward to form a hub, which serves as the sliding surface for the release bearing.

From the repeated clutch apply and release cycles, the friction material on the disc will wear. To compensate for this wear, the clutch pedal is equipped with a self-adjuster which automatically adjusts cable length to maintain correct pedal height and throw-out bearing preload.



C5566-A

DESCRIPTION



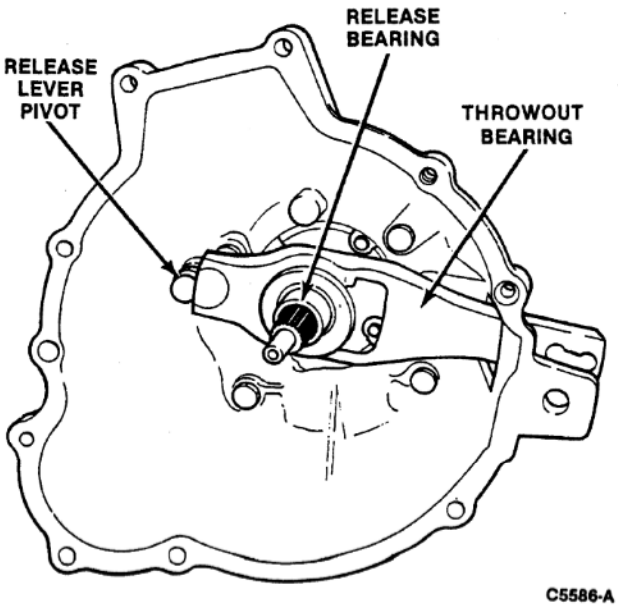
REMOVAL AND INSTALLATION

CLUTCH RELEASE LEVER AND BEARING

Removal

NOTE: The clutch release bearing is lubricated and permanently sealed during manufacture. Never wash or soak the bearing in cleaning solvent. The solvent will dissolve the lubricant and ruin the bearing.

1. Remove the transmission. If necessary, refer to Section 16-33.
2. Disengage the release lever from the pivot ball.
3. Remove the release lever and bearing from the flywheel housing.



REMOVAL AND INSTALLATION

CLUTCH RELEASE LEVER AND BEARING

Installation

1. Apply a light film of lubricant C1AZ-19590-B, or equivalent on the following areas:
   - Transmission front bearing retainer
   - Release lever fork and anti-rattle spring where they contact the release bearing hub
   - Clutch finger contact surface on release bearing
2. Fill the grease groove in release bearing hub with lubricant C1AZ-19590-B, or equivalent.

NOTE: Fill only the groove and remove all excess grease from the bearing hub. If excess grease remains in the bearing hub, it can be forced onto the clutch disc splines where it may contaminate the clutch friction surfaces.

3. Position the release lever and bearing in the flywheel housing. Be sure the lever is properly engaged on the pivot ball.
4. Install the transmission. If necessary, refer to Section 16-33.

CLUTCH PRESSURE PLATE AND DISC

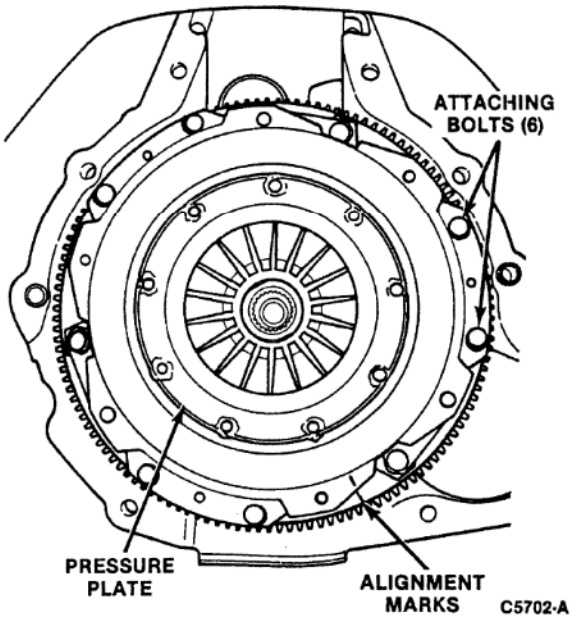
SPECIAL SERVICE TOOL REQUIRED:

Clutch Aligner T71P-7137-H

Removal

CAUTION: Do not get oil or grease on the clutch disc facing. Even a small trace of oil or grease may cause clutch grabbing or slipping. Handle the disc by its edges and do not touch the facings.

1. Remove the transmission. If necessary, refer to Section 16-33.
2. If the pressure plate will be reused, paint or scribe index marks on the pressure plate and flywheel for assembly reference.



3. Remove the pressure plate attaching bolts, the pressure plate and the clutch disc.

NOTE: Loosen the attaching bolts one turn at a time to release the pressure plate spring tension evenly. Failure to release the spring tension evenly could cause distortion of the pressure plate.

Installation

1. If a new clutch is being installed, sand the friction surfaces on the pressure plate and flywheel using medium-fine emery cloth, or equivalent aluminum oxide paper.

   Sand lightly until the friction surfaces are covered with fine scratch lines that run across the surface. This will break the glaze on these surfaces and remove any carboned oil deposits. The new clutch disc will seat smoothly and quickly against the sanded surfaces. Before sanding the flywheel, cover the crankshaft pilot bearing with a clean shop towel.

REMOVAL AND INSTALLATION

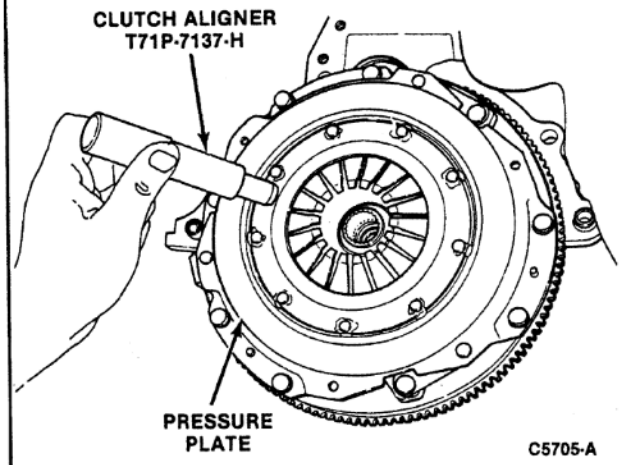
CLUTCH PRESSURE PLATE AND DISC

Installation (Continued)

After sanding the flywheel, remove all traces of grit and oil film using a shop towel saturated with denatured alcohol. Do not use any petroleum-based solvents to clean the flywheel.

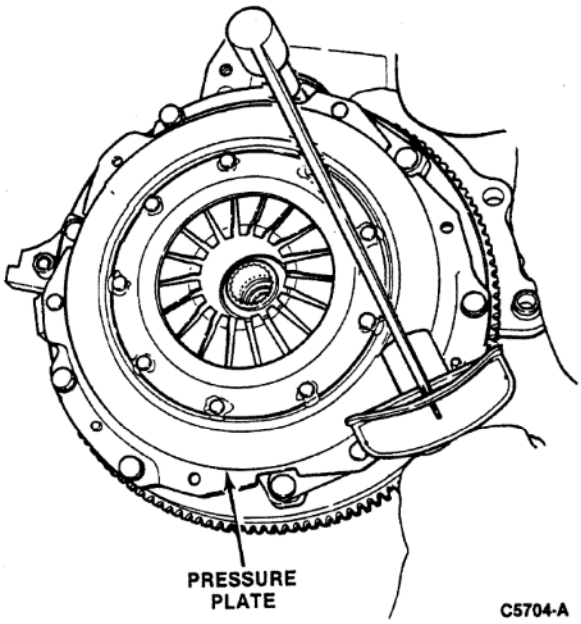
2. Coat the crankshaft pilot bearing with a small amount of lubricant C1AZ-19590-B, or equivalent. Do not use an excessive amount of lubricant which could be thrown onto the clutch friction surfaces.

3. Position the clutch disc and pressure plate on the flywheel. Before installing the pressure plate attaching bolts align the index marks made during removal and install clutch aligner T71P-7137-H, or equivalent.



NOTE: Before installing the clutch disc, be sure the correct side will be facing the flywheel. A new disc will be stamped FLYWHEEL to indicate the correct installation direction. Installation direction is correct when the damper springs face away from the flywheel.

4. Tighten the pressure plate attaching bolts one turn at a time to 20 to 25 N·m (15 to 19 lb-ft).



5. Remove the clutch disc alignment tool.

6. Install the transmission. If necessary refer to Section 16-33.

REMOVAL AND INSTALLATION

CRANKSHAFT PILOT BEARING

SPECIAL SERVICE TOOLS REQUIRED:

Puller Attachment	T58L-101-A
Slide Hammer	T50T-100-A
Pilot Bearing Replacer	T71P-7137-C
Clutch Aligner	T71P-7137-H

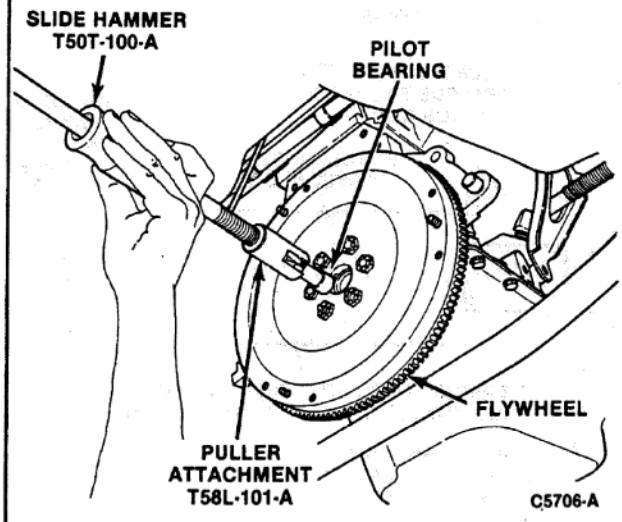
Removal

NOTE: The crankshaft pilot bearing cannot be reused after removal. A new bearing must be installed.

1. Remove the transmission. If necessary, refer to Section 16-33.
2. Remove the clutch pressure plate and disc. If necessary, refer to the procedure in this section.

CAUTION: Do not get oil or grease on the clutch disc facing. Even a trace of oil or grease may cause clutch grabbing or slipping. Handle the disc by its edges and do not touch the facings.

3. Remove the crankshaft pilot bearing using Puller Attachment T58L-101-A and Slide Hammer T50T-100-A, or equivalents.

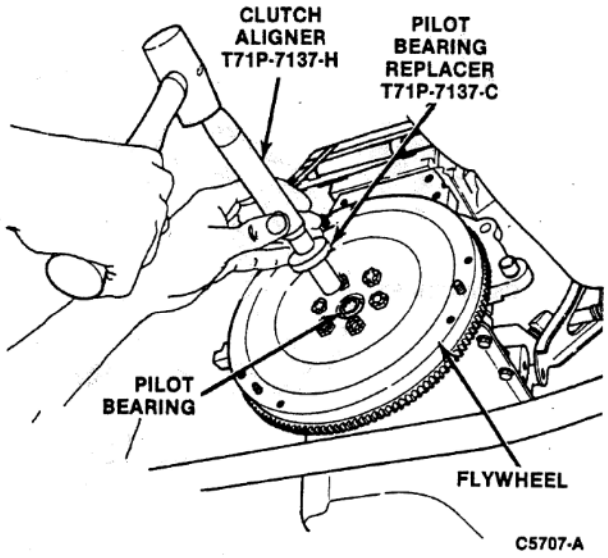


Installation

1. Coat the crankshaft pilot bearing bore with a small amount of Lubricant C1AZ-19590-B, or equivalent.

   Do not use an excessive amount of lubricant which could be thrown onto the clutch friction surfaces.
2. Install the crankshaft pilot bearing using Pilot Bearing Replacer T71P-7137-C and Clutch Aligner T71P-7137-H, or equivalents.

NOTE: The bearing seal must be facing outward.



3. Install the clutch disc and pressure plate. If necessary, refer to the procedure in this section.
4. Install the transmission. If necessary, refer to Section 16-33.

REMOVAL AND INSTALLATION

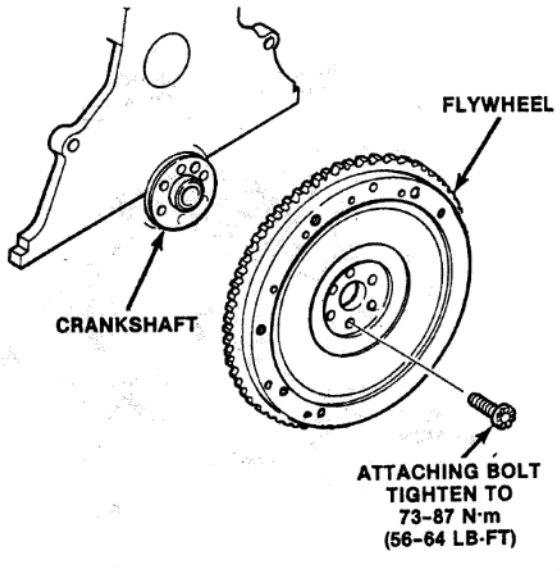
ENGINE FLYWHEEL

Removal

1. Remove the transmission. If necessary, refer to Section 16-33.
2. Remove the clutch pressure plate and disc. If necessary, refer to the procedure in this section.

CAUTION: Do not get oil or grease on the clutch disc facing. Even a trace of oil or grease may cause clutch grabbing or slipping. Handle the disc by its edges and do not touch the facings.

3. Remove the flywheel attaching bolts and the flywheel.



Installation

1. Position the flywheel on the crankshaft and install the attaching bolts.

   Tighten the attaching bolts to 73 to 87 N·m (56 to 64 lb-ft).
2. Install the clutch disc and pressure plate. If necessary, refer to the procedure in this section.
3. Install the transmission. If necessary, refer to Section 16-33.

FLYWHEEL HOUSING DOWELS

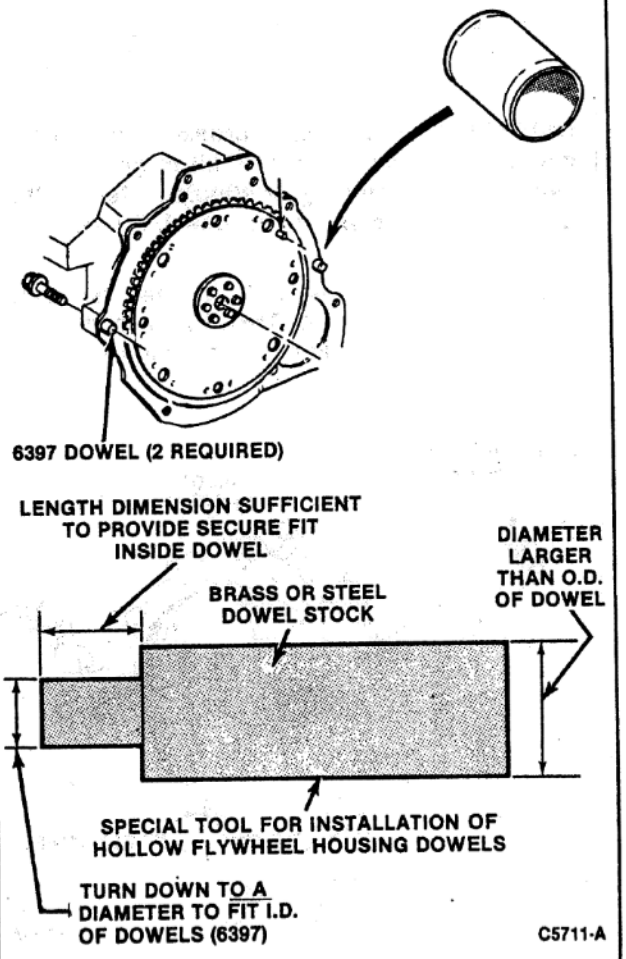
Removal

Work the dowel out of the cylinder block using a pair of locking-type pliers. Use care to prevent damage to the dowel bore and the surrounding area.

Installation

Install the dowels using a suitable driver and hammer. Hold the dowel squarely and drive into the bore until fully seated.

NOTE: A suitable driver can be fabricated from steel or brass dowel stock using the dimensions shown in the illustration below.



REMOVAL AND INSTALLATION

TRANSMISSION FRONT BEARING RETAINER/SEAL

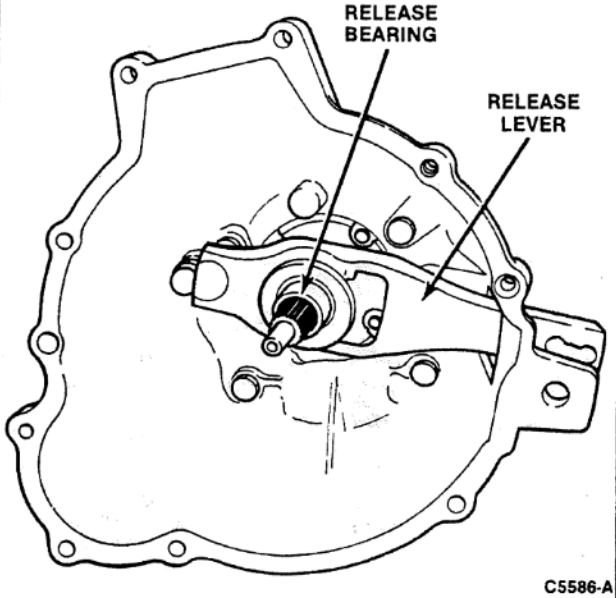
SPECIAL SERVICE TOOLS REQUIRED:

Inner Race Remover	T75P-3504-G
Slide Hammer	T50T-100-A

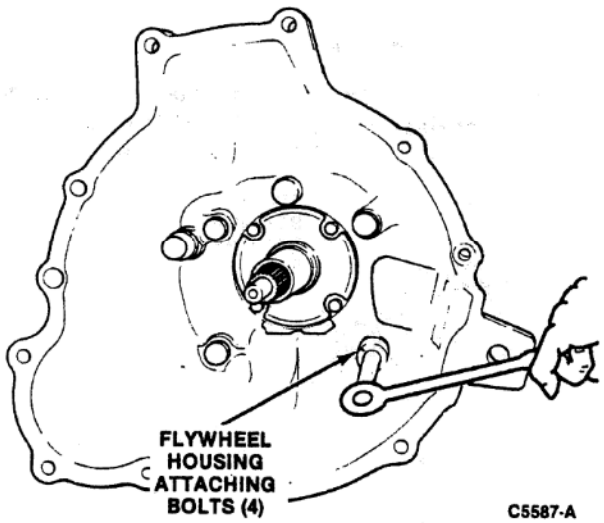
Removal

1. Remove the transmission. If necessary, refer to Section 16-33.

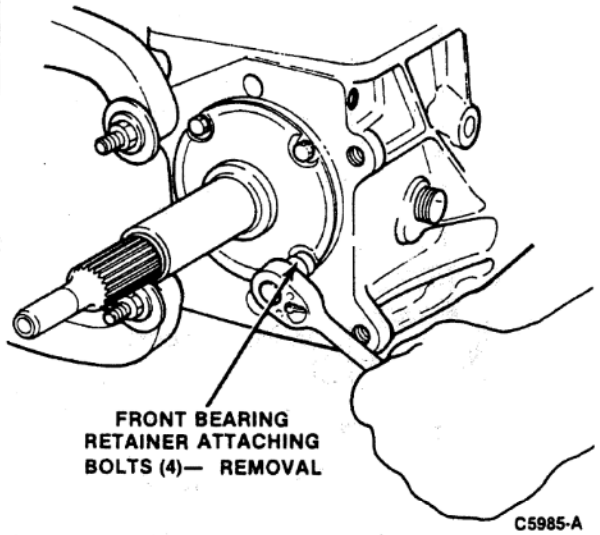
2. Remove the clutch release bearing and lever from the flywheel housing.



3. Remove the flywheel housing.



4. Remove the front bearing retainer.

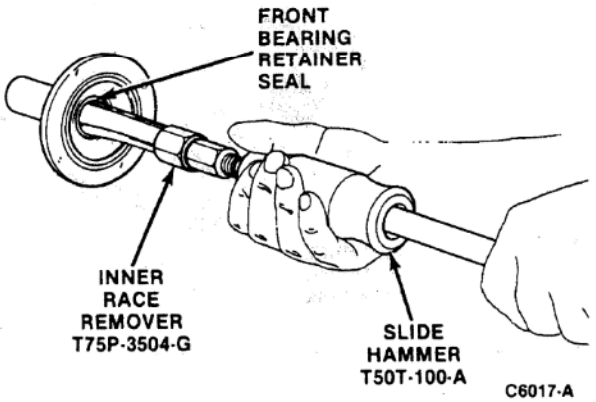


REMOVAL AND INSTALLATION

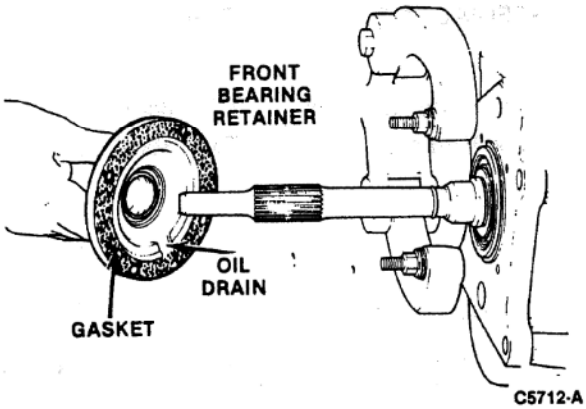
TRANSMISSION FRONT BEARING RETAINER/SEAL

Removal (Continued)

5. Remove the front bearing retainer seal using Inner Race Remover T75P-3504-G and Slide Hammer T50T-100-A, or equivalent.

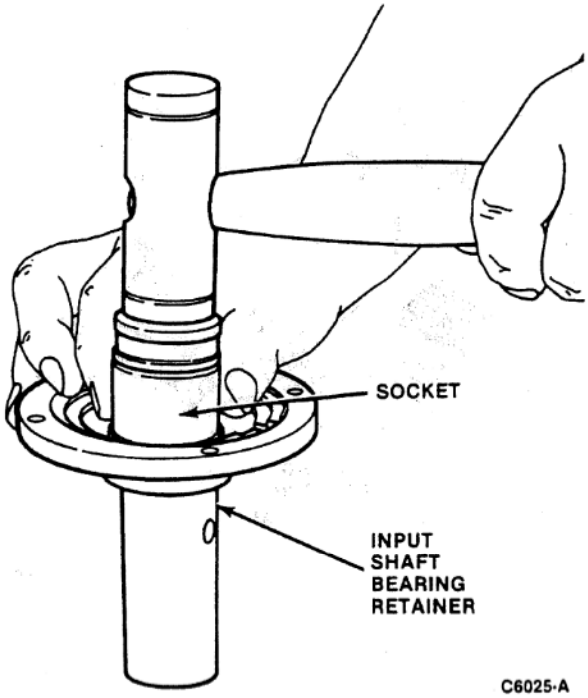


2. Install a new gasket, align the oil drain holes and position the front bearing retainer on the transmission.

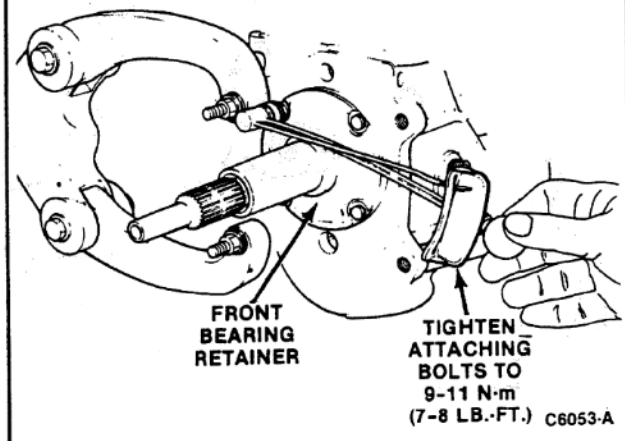


Installation

1. Install the front bearing retainer seal using a socket of suitable size.



3. Install the front bearing retainer attaching bolts and tighten to 9 to 11 N·m (7 to 8 lb-ft).

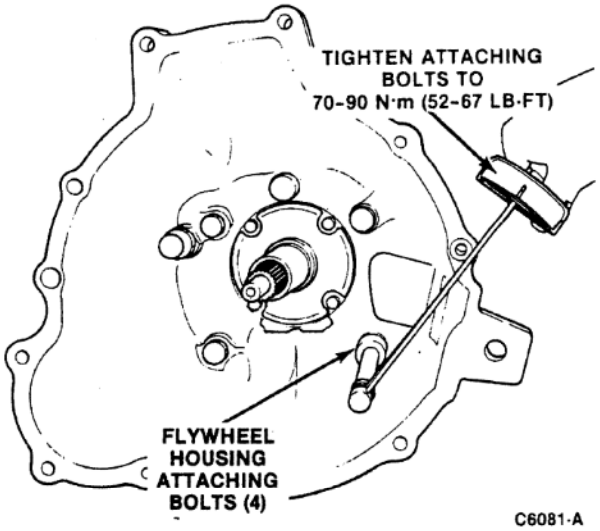


REMOVAL AND INSTALLATION

TRANSMISSION FRONT BEARING RETAINER/SEAL

Installation (Continued)

4. Install the flywheel housing and tighten the attaching bolts to 70 to 90 N·m (52 to 67 lb-ft).

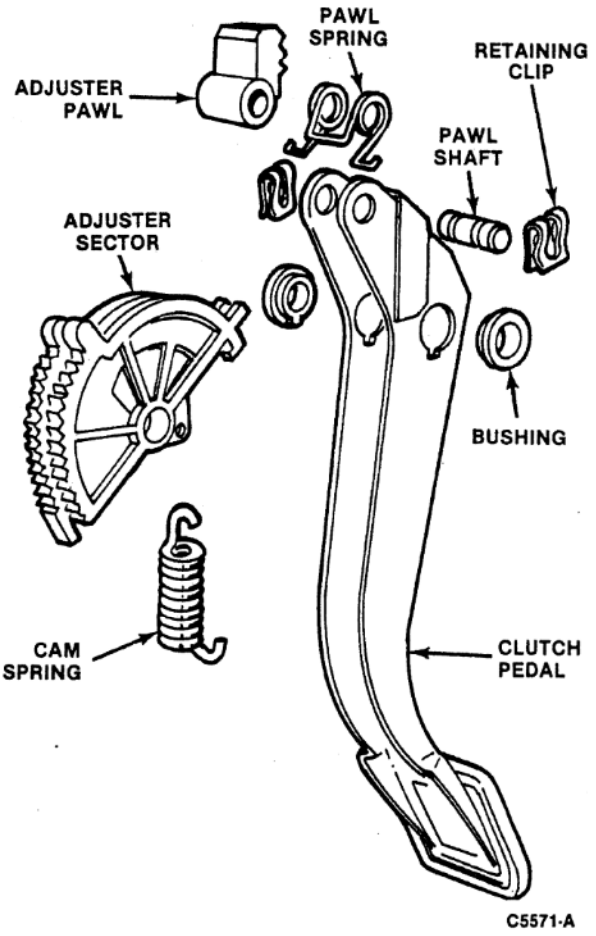


5. Install the clutch release lever and bearing.

6. Install the transmission. If necessary, refer to Section 16-33.

CLUTCH PEDAL/SELF-ADJUSTER

SELF-ADJUSTER DISASSEMBLED VIEW



Removal

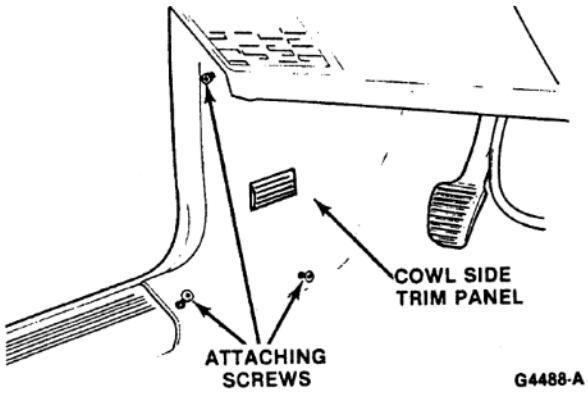
1. Disconnect the battery negative cable.
2. Remove the sound-deadening panel, located under the instrument panel.

REMOVAL AND INSTALLATION

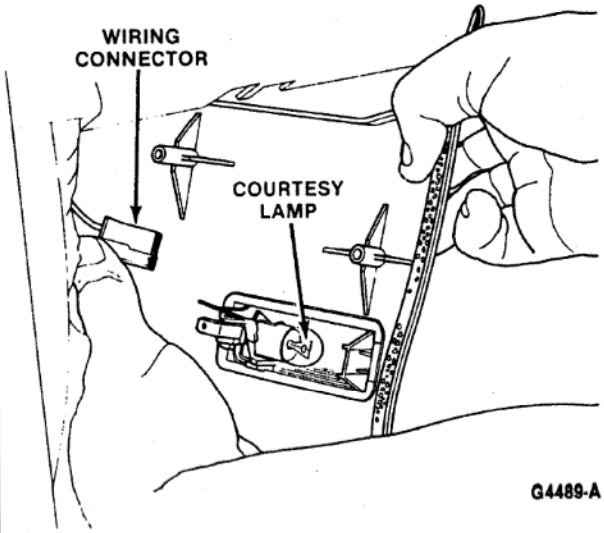
CLUTCH PEDAL/SELF-ADJUSTER

Removal (Continued)

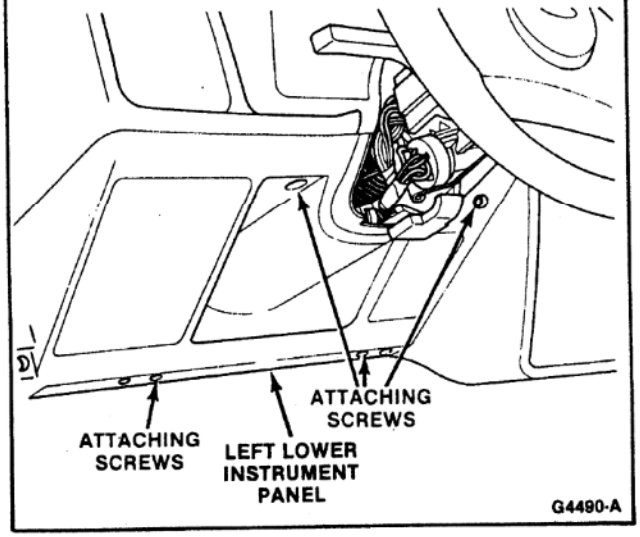
3. Remove the side cowl trim panel attaching screws.



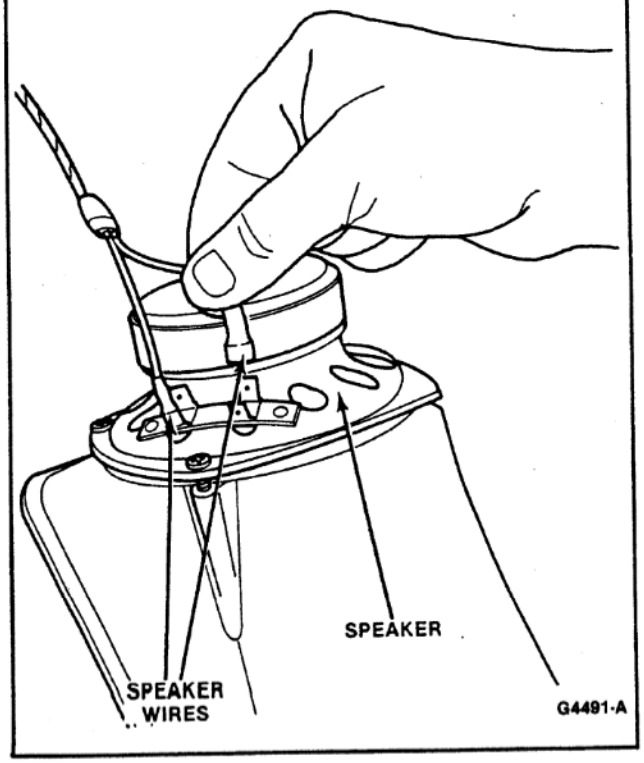
4. Pull the side cowl trim panel away from the body, disconnect the courtesy light wiring and remove the panel.



5. Remove the steering column lower shroud and the left lower instrument panel attaching screws.



6. Lower the instrument panel, disconnect the radio speaker wires and remove the panel.



REMOVAL AND INSTALLATION

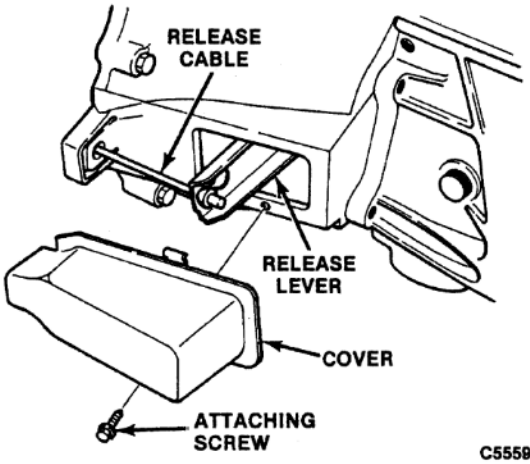
CLUTCH PEDAL/SELF-ADJUSTER

Removal (Continued)

7. Wedge a block of wood approximately seven inches long under the clutch pedal.

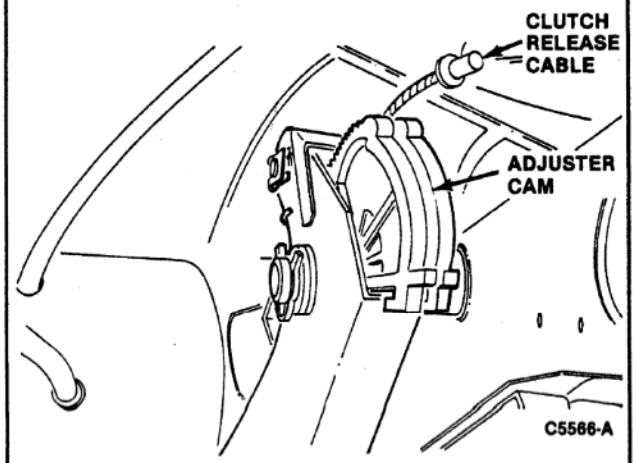
   Holding the pedal above its normal position will disengage the clutch cable self-adjuster.

8. Raise the vehicle.
9. Remove the clutch release lever cover.

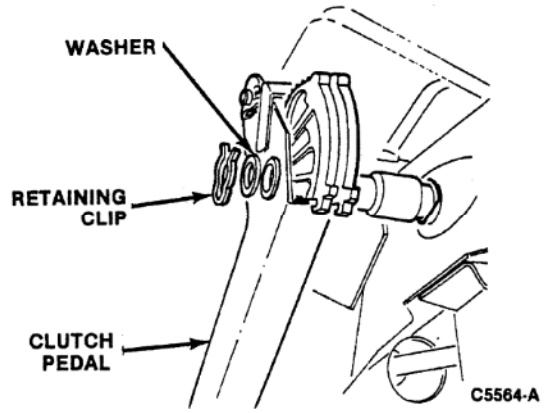


10. Pull rearward on the clutch release cable and disengage from the release lever.

11. Lower the vehicle.
12. Unhook the the clutch release cable from the self-adjuster cam.

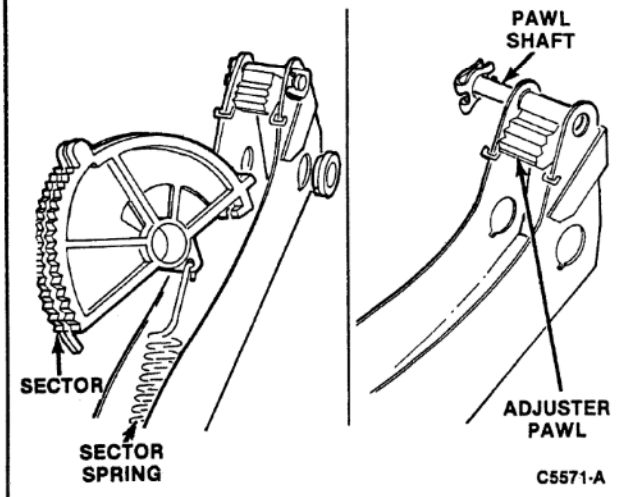


13. Using a suitable hook, remove the clutch pedal retaining clip.



14. Remove the clutch pedal and washer from the shaft.

15. Remove the pedal bushings, adjuster sector and sector spring.



16. Remove the retaining clip from the adjuster pawl shaft.

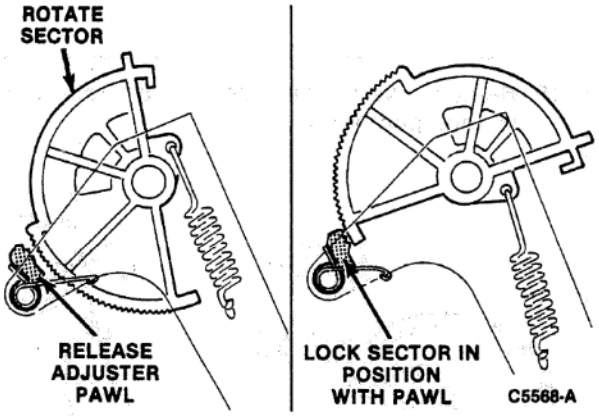
17. Remove the adjuster pawl, spring, and shaft.

REMOVAL AND INSTALLATION

CLUTCH PEDAL/SELF-ADJUSTER

Installation

1. Install the adjuster pawl, shaft, spring and retaining clip.
2. Connect the sector spring to the clutch pedal and sector. Pull the sector into position against spring tension and secure in position with the pedal bushings.
3. Lift the pawl and rotate the sector to the position shown in the illustration below.



4. Lubricate the bushings and pedal shaft with a graphite-type grease and install the pedal.
5. Install the pedal washer and retaining clip.
6. Position the clutch release cable in the adjuster sector.
7. Position the block of wood under the clutch pedal.
8. Raise the vehicle.
9. Connect the clutch release cable to the release lever and install the cover.
10. Lower the vehicle and remove the block of wood.
11. Position the left lower instrument panel, connect the radio speaker wires, and install the attaching screws.
12. Install the steering column lower shroud.
13. Position the cowl trim panel, connect the courtesy light wires, and install the attaching screws.
14. Install the sound-deadening panel.
15. Connect the battery negative cable.

CLUTCH CABLE

Removal

Perform Steps 1 through 12 in the Clutch Pedal/Self-Adjuster removal procedure and remove the clutch cable from the vehicle.

Installation

Position the clutch cable in the vehicle and perform Steps 6 through 15 in the Clutch Pedal/Self-Adjuster installation procedure.

COMPONENT INSPECTION CHART
CLUTCH

Cleaning: Clean the pressure plate and flywheel surfaces with a suitable solvent such as alcohol to be sure surfaces are free from any oil film. Do not use cleaners with petroleum base, and do not soak or wash the pressure plate in solvent. The clutch release bearing is lubricated and permanently sealed during manufacture. Never wash or soak the bearing in cleaning solvent. The solvent will dissolve the lubricant and ruin the bearing.

CAUTION: Do not get oil or grease on the clutch disc facing. Even a trace of oil or grease may cause clutch grabbing or slipping. Handle the disc by its edges and do not touch the facings.

Dust, dirt, and oil can be removed with a vacuum cleaner or shop cloth soaked in alcohol.

WARNING: Breathing asbestos dust is hazardous to your health.

Dust and dirt present on a clutch assembly may contain asbestos fibers that are hazardous to your health when made airborne by cleaning with compressed air or by dry brushing.

Clutch components should be cleaned using a vacuum cleaner recommended for use with asbestos fibers. Dust and dirt from the vacuum should be disposed of in a manner that prevents dust exposure, such as sealed bags. The bag must be labeled per OSHA instructions and the trash hauler notified as to the bag's contents.

If a vacuum suitable for asbestos is not available, cleaning should be done wet. If dust generation is still possible, technicians should wear government-approved toxic dust purifying respirators.

OSHA requires areas where asbestos dust generation is possible to be isolated and posted with warning signs. Only technicians concerned with performing clutch service should be present in the area.

COMPONENT	CHECK FOR
RELEASE BEARING	• Scoring or excessive wear on the clutch contact surface • Excessive play by spinning it by hand — The bearing should spin freely but with enough drag to indicate the presence of grease. • Roughness or noise — Press the bearing against a flat surface and while maintaining pressure, rotate the bearing. • Burrs which may cause unequal pressure on the front bearing retainer — Small burrs and score marks can be polished out with crocus cloth.
RELEASE LEVER	• Scoring or excessive wear on the release bearing contact area • Broken or bent condition • Worn pivot ball socket • Worn release cable slot • Loss of anti-rattle spring tension — The spring must hold the lever tight against the pivot ball.

COMPONENT	CHECK FOR
TRANSMISSION FRONT BEARING RETAINER	• Scoring or excessive wear on the release bearing contact surface • Oil leakage past the input shaft seal — Too much lubricant in the transmission, or a plugged transmission vent can force lubricant past the seal onto the input shaft. • Cracks or other damage
TRANSMISSION INPUT SHAFT	• Scoring or excessive wear on the pilot bearing contact surface — The contact area must be smooth and bright, without grooves or ridges. • Worn or chipped clutch disc splines • Worn, galled, scored or otherwise damaged output shaft roller bearing
PRESSURE PLATE	• Scoring or excessive wear on the clutch disc contact surface • Heat checking • Warped condition — Using a straight edge and feeler gauge, check the flatness of the clutch disc surface. It must be flat to within 1.0 mm (0.039 in.). • Loose or damaged clutch spring rivets • Elongated or cracked mounting bolt holes • Worn, bent or broken release fingers — The inner ends of the finger should have an even wear pattern.
CLUTCH DISC	• Excessive wear — The clutch disc is worn out if the facing material has worn to within 0.3 mm (0.01 in.) of the rivet heads. • Oil or grease contamination of the disc facing — Any excessive amount of lubricant on the pilot bearing or release bearing will find its way to the clutch disc facings. Too much lubricant in the transmission or a plugged transmission vent will force lubricant past the input shaft seal onto the input shaft and clutch disc facings. Also, a rear main bearing oil seal leak can contaminate the facings. • Loose facing or hub rivets • Worn, chipped or burred input shaft splines — Slide the disc onto the transmission input shaft to make sure it is free on the splines. If the splines on the disc or shaft are burred, remove the burrs with a fine file or stone.

COMPONENT	CHECK FOR
CLUTCH DISC (Continued)	— The disc splines and input shaft splines must be snug fit. • Broken or distorted torsional springs — Springs loose enough to rattle will not cause noise when the vehicle is operating.
FLYWHEEL	• Scoring or excessive wear in the clutch disc contact area • Cracking or heat checking • Excessive runout • Loose attaching bolts — Tighten the bolts to 73 to 87 N·m (56 to 64 lb-ft).
FLYWHEEL HOUSING AND DOWELS	• Bent, broken or missing dowels • Nicks or burrs which could cause misalignment of the housing • Cracks • Elongated or otherwise damaged bolt holes • Worn or damaged release lever pivot ball

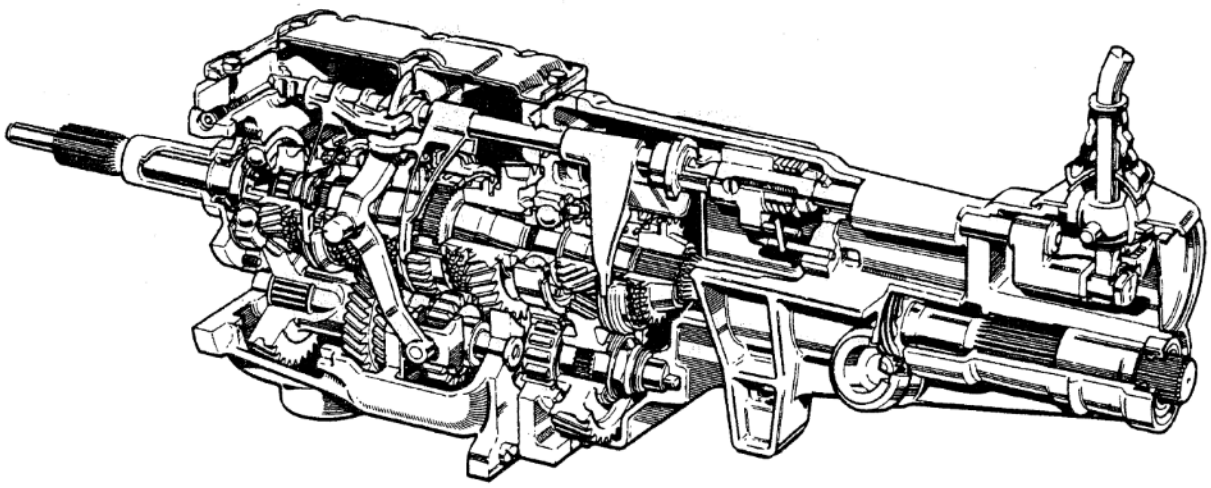
SECTION 16-33 Five-Speed Manual Transmission

SUBJECT	PAGE
DESCRIPTION	16-33-1
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Front Bearing Retainer Seal	16-33-31
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Input Shaft Bearing	16-33-32
Output Shaft	16-33-22
Output Shaft	16-33-33
Output Shaft Bearing	16-33-25
Output Shaft Bearing	16-33-32
Shifter Shaft Seal	16-33-26
Synchronizer	16-33-26
Synchronizer	16-33-31

SUBJECT	PAGE
DISASSEMBLY AND ASSEMBLY (Cont'd.)	
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FLUID LEVEL CHECK	
Air Baffle	16-33-48
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REMOVAL AND INSTALLATION	
Extension Housing Bushing	16-33-8
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Shift Lever and Boot	16-33-9
Transmission	16-33-6

DESCRIPTION

The five-speed manual transmission has three forward reduction gear ratios, a one-to-one (4th) gear ratio and an overdrive (5th) gear ratio. These forward ratios are provided through helical-cut, constant-mesh gears. Reverse gear is provided through an idler gear which slides along a shaft to engage spur gears on the cluster gear and output shaft. All gears, except the fifth-speed gears, are contained in the case. The fifth-speed gears are located on the back of the case in the extension housing.



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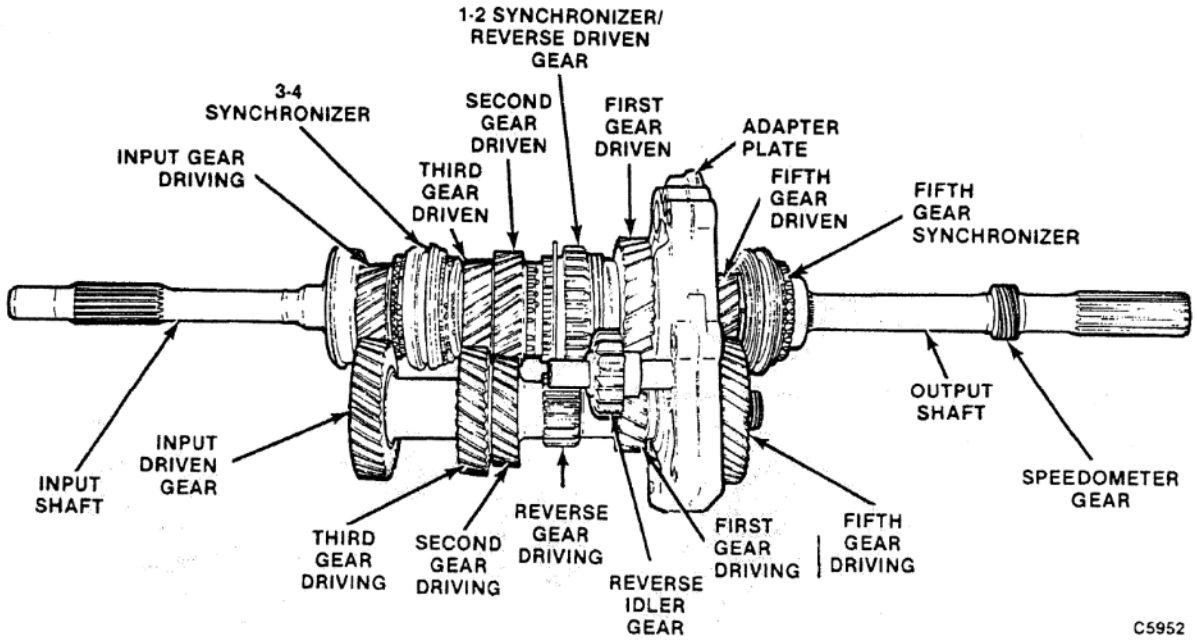
DESCRIPTION (Continued)

Three synchronizers are used to lock the driven gears to the output shaft. Two synchronizers provide first through fourth gears, while the third synchronizer provides fifth gear. The synchronizers are shifted by three forks attached to a common shift rail. A system of interlocks on the shaft prevents the engagement of more than one gear at any one time. The shift rail extends from the shift lever mounted on the extension housing to the front of the case. At the front of the case a spring-loaded plunger contacts the shift rail to provide the shift detent. Reverse gear requires an intermediate lever between the shift rail and the sliding gear. The lever is mounted on a pivot pin which is pressed into the left side of the case. A spring returns the lever to the released position when the transmission is shifted out of reverse.

The input and output shafts are supported in the case on ball bearings to provide durability and quiet operation. The rear of the cluster gear is supported in the case on a roller bearing. The front of the cluster gear is supported on 21 needle bearings installed between the countershaft and cluster gear bore on 1985 and 1986 model units. For 1987 the front of the cluster gear is supported by a caged needle bearing.

POWERFLOW

NEUTRAL/COMPONENT IDENTIFICATION

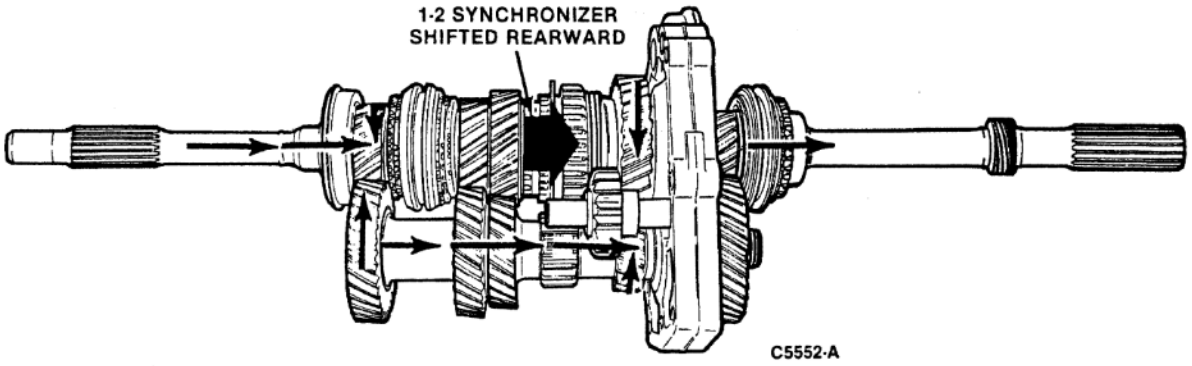


POWERFLOW

FIRST GEAR

RATIO—3.36:1

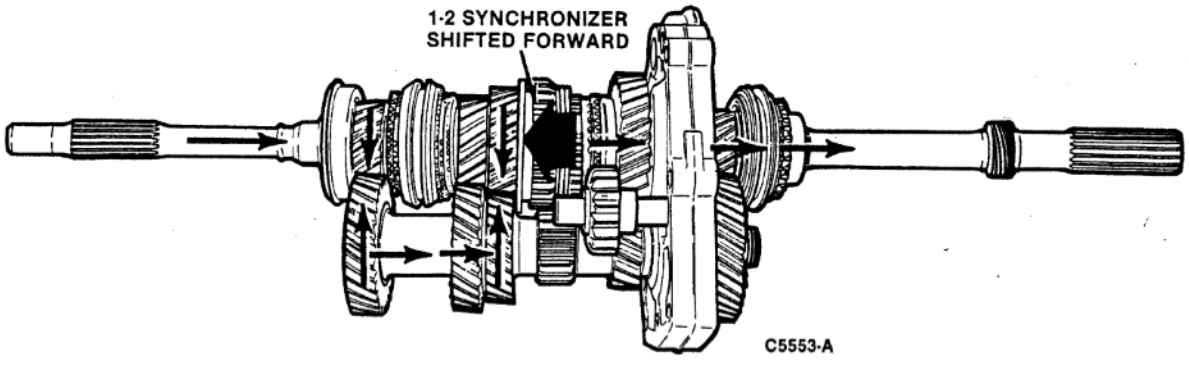
- The first/second synchronizer hub is splined to the output shaft.
- When the synchronizer sleeve is shifted rearward, first gear is locked to the output shaft through the synchronizer blocking ring, sleeve and hub.
- The input gear is driving the cluster gear.
- First gear on the cluster gear drives first gear on the output shaft.
- The output shaft is driven in reduction.



SECOND GEAR

RATIO—1.81:1

- The first/second synchronizer hub is splined to the output shaft.
- When the synchronizer sleeve is shifted forward, second gear is locked to the output shaft through the synchronizer blocking ring, sleeve and hub.
- The input gear is driving the cluster gear.
- Second gear on the cluster gear drives second gear on the output shaft.
- The output shaft is driven in reduction.

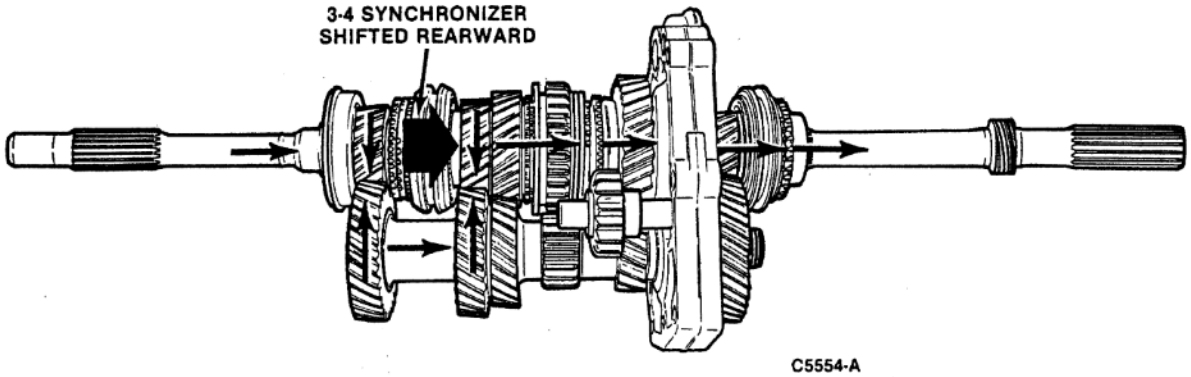


POWERFLOW

THIRD GEAR

RATIO—1.26:1

- The third/fourth synchronizer hub is splined to the output shaft.
- When the synchronizer sleeve is shifted rearward, third gear is locked to the output shaft through the synchronizer blocking ring, sleeve and hub.
- The input gear is driving the cluster gear.
- Third gear on the cluster gear drives third gear on the output shaft.
- The output shaft is driven in reduction.

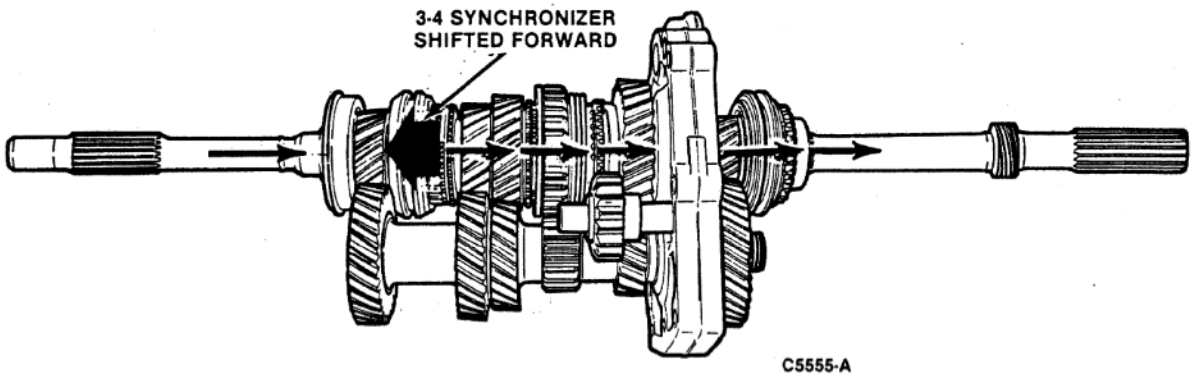


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FOURTH GEAR

RATIO—1.00:1

- The third/fourth synchronizer hub is splined to the output shaft.
- When the synchronizer sleeve is shifted forward, the input shaft is locked to the output shaft through the synchronizer blocking ring, sleeve and hub.
- The input and output shafts are now linked into a single shaft.
- The input and output shafts are driven at the same speed.



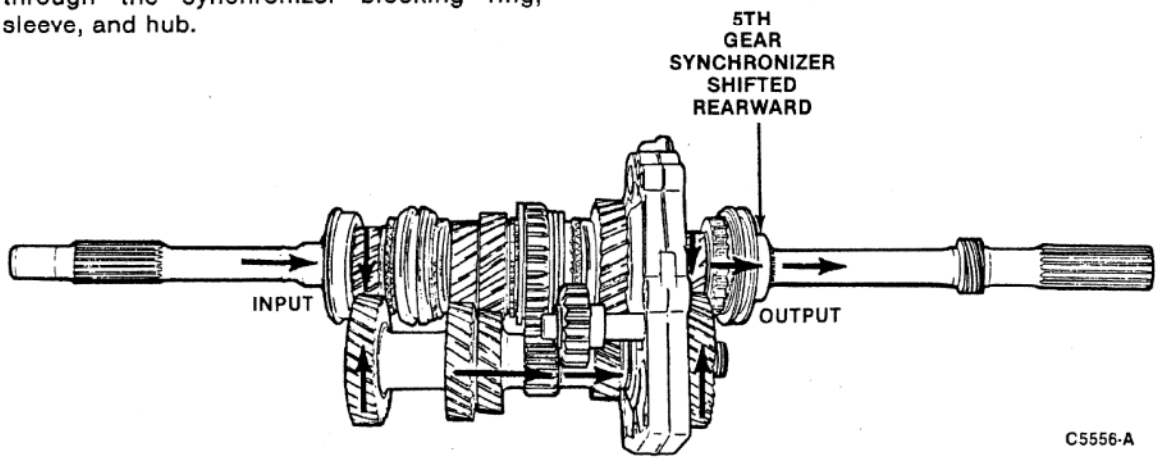
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POWERFLOW

FIFTH GEAR

RATIO—0.83.1

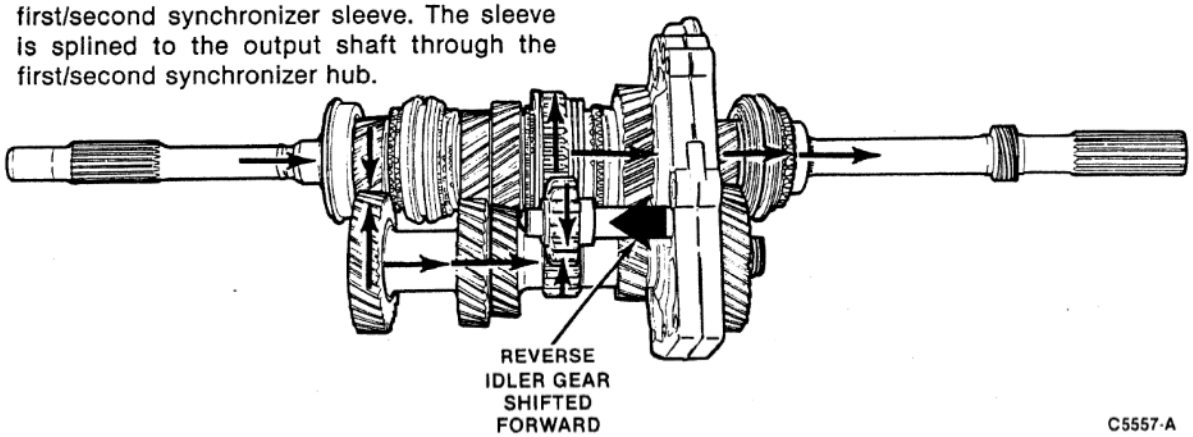
- The fifth gear synchronizer is splined to the output shaft.
- When the synchronizer sleeve is shifted rearward, fifth gear is locked to the output shaft through the synchronizer blocking ring, sleeve, and hub.
- The input gear is driving the cluster gear.
- Fifth gear is pressed onto the cluster gear and drives the fifth gear on the output shaft.
- The output shaft is driven in overdrive.



REVERSE GEAR

RATIO—3.36:1

- To reverse output shaft rotation, an idler gear is shifted into position between the reverse gear on the cluster gear and the reverse gear on the output shaft.
- The reverse gear on the output shaft is machined into the outside diameter of the first/second synchronizer sleeve. The sleeve is splined to the output shaft through the first/second synchronizer hub.
- The input gear is driving the cluster gear.
- The reverse gear on the cluster gear drives the reverse idler gear.
- The idler gear drives the gear on the output shaft.
- The idler gear reverses the rotation of the output shaft and drives it in reduction.



POWERFLOW

OVERDRIVE

Gears one through three are reduction gears because the input shaft has to turn more than once to produce one turn at the end of the output shaft. For example, in first gear the input shaft turns almost three and a half times to produce a single output shaft rotation. Shifts to second and third require fewer and fewer input shaft turns to produce a single output shaft rotation. This reduction between input and output shaft rotation is accomplished through the input, cluster and output shaft gear ratios.

When the transmission is shifted into fourth gear, the third/fourth synchronizer locks the input shaft to the output shaft to form a single shaft. The locked shafts transmit engine torque from the clutch to the driveshaft in a one-to-one ratio.

In fourth gear, each time the engine, clutch and input shaft make a single rotation, the output shaft and driveshaft also make a single rotation.

In overdrive, the input shaft will turn less than a complete revolution to produce a full revolution of the output shaft. In overdrive, the input-to-output gear ratio becomes less than one. Each time the input shaft makes about eight-tenths of a turn, the output shaft makes one complete turn. In effect, the output shaft and driveshaft are now turning faster than the input shaft, clutch and engine.

For fuel economy the XR4Ti overdrive gear allows a reduction in engine speed without reduction of vehicle speed. On the top end, overdrive allows increased vehicle speed within the rpm and torque capabilities of the engine.

REMOVAL AND INSTALLATION

TRANSMISSION

Removal

1. Wedge a block of wood approximately seven inches long under the clutch pedal.

   Holding the pedal above its normal position will disengage the clutch cable self adjuster.
2. Open the hood, disconnect the battery negative cable, and raise the vehicle.
3. Remove the nuts attaching the catalytic converter inlet pipe to the turbocharger.
4. Remove the attaching nuts at the catalytic converter outlet-to-muffler inlet flange and the catalytic converter support bracket.
5. Remove the catalytic converter and inlet pipe as an assembly.
6. Remove the driveshaft. If necessary, refer to Section 15-60.
7. Install a suitable plug in the extension housing seal to prevent fluid leakage.
8. Remove the starter. If necessary, refer to Section 28-02.
9. Remove the front stabilizer bar to body U-brackets and the body stiffener rod.
10. If equipped, remove the transmission air baffle. A removal and installation procedure is included in the fluid level check procedure found at the end of this section.
11. Position a block of wood between the stabilizer bar and the body side rail.
12. Support the transmission with a suitable transmission jack.
13. Remove the bolt attaching the rear mount to the transmission.
14. Remove the bolts attaching the rear mount to the body and remove the mount.
15. Loosen the engine mount attaching nuts until only two or three threads are visible on the end of the stud.
16. Position a block of wood against the engine oil pan and raise the front of the engine using a suitable stand.

    Raise the engine until the stud nuts on the engine mounts contact the crossmember.

    As the engine tilts downward, lower the transmission jack.
17. Disconnect the wire to the back up light switch.
18. Disconnect the wire to the neutral safety switch.
19. Remove the attaching bolts and raise the transmission shift lever out of the extension housing (TORX No. 40).
20. Remove the snap ring and pull the speedometer cable out of the extension housing.
21. Remove the clutch release lever cover.

REMOVAL AND INSTALLATION

TRANSMISSION

Removal (Continued)

22. Pull rearward on the clutch release cable and disengage from the release lever.
23. Remove the attaching screws from the speedometer cable routing clips (two places).

    Position the cable out of the way on the left side of the vehicle.
24. Remove the bolt attaching the engine rear cover plate to the flywheel housing.
25. Remove the flywheel housing attaching bolts located at the top of the housing.
26. Remove the four remaining flywheel housing attaching bolts.
27. Pull the transmission rearward until the flywheel housing contacts the body.

    Raise the rear of the transmission and pull rearward to clear the body.

    Lower the rear of the transmission and pull rearward to remove.

Installation

1. Align the transmission input shaft with the clutch pressure plate and push the transmission forward until the flywheel housing contacts the body.

   Raise the rear of the transmission, as necessary, to clear the body.

   Lower the rear of the transmission and push forward into position. Rock the transmission slightly to align the input shaft and clutch disc splines.

   Use care to prevent damage to the transmission pilot bearing in the end of the crankshaft.
2. Install the flywheel housing attaching bolts.

   Tighten the bolts to 38 to 51 N·m (28 to 38 lb-ft).
3. Install the engine rear cover attaching bolt.

   Tighten the bolt to 38 to 51 N·m (28 to 38 lb-ft).
4. Remove the stand and block of wood supporting the engine.
5. Raise the transmission jack until the transmission is in its normal position.
6. Tighten the engine mount stud nuts to 68 to 95 N·m (50–70 lb-ft).
7. Lower the transmission.
8. Position the shift lever and install the attaching bolts.
9. Connect the back up light switch wire.
10. Connect the wire to the neutral safety switch.
11. Position the speedometer cable in the extension housing and install the snap ring.
12. Install the attaching screws in the speedometer cable routing clips.
13. Raise the transmission.
14. Position the rear mount and install the body attaching bolts.

    Tighten the bolts to 34 to 48 N·m (25 to 35 lb-ft).
15. Install the rear mount to transmission attaching bolt.

    Tighten the bolt to 68 to 95 N·m (50 to 70 lb-ft).
16. If equipped, install the transmission air baffle. A removal and installation procedure is included in the fluid level check procedure found at the end of this section.
17. After removing the block of wood, install the stabilizer bar U-brackets and the body stiffener rod.

    Tighten the attaching bolts to 45 to 56 N·m (33 to 41 lb-ft).
18. Connect the clutch cable to the release lever and install the cover.
19. Install the starter.
20. Remove the plug from the extension housing and install the driveshaft.
21. Install the catalytic converter.
22. Install the flange attaching nuts at the converter outlet-to-muffler inlet connection.
23. Install the converter inlet-to-turbocharger attaching nuts.
24. Align the exhaust system and tighten the attaching nuts to 28 to 40 N·m (21 to 30 lb-ft) at the converter outlet and to 34 to 48 N·m (25 to 35 lb-ft) at the turbocharger.
25. Lower the vehicle, connect the battery negative cable, and close the hood.
26. Remove the block of wood holding the clutch pedal.

    Press the clutch cable to the floor several times to adjust the clutch cable freeplay.

REMOVAL AND INSTALLATION

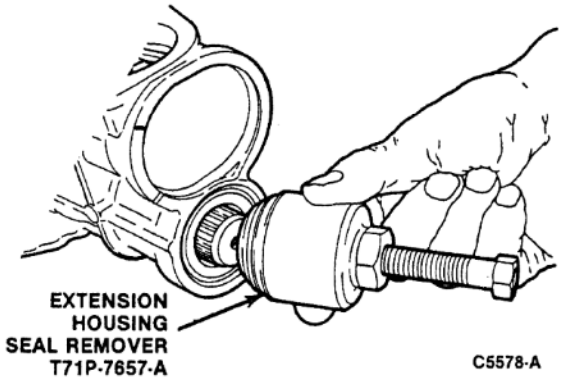
EXTENSION HOUSING SEAL

SPECIAL SERVICE TOOLS REQUIRED:

Seal Remover	T71P-7657-A
Seal Replacer	T71P-7095-A
Extension Housing Bushing Replacer (Adapter used with T71P-7095-A)	T74P-7095-A

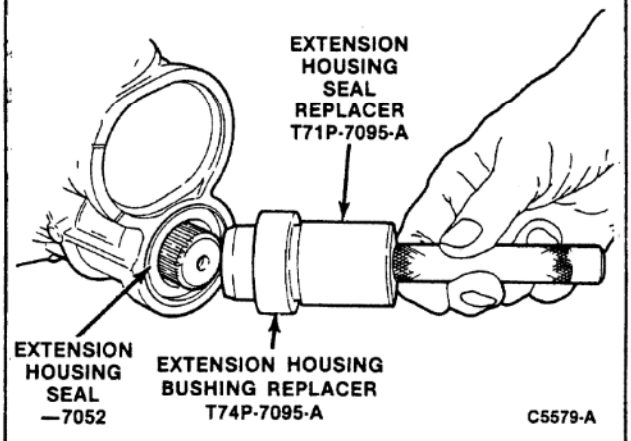
Removal

1. Remove the driveshaft. If necessary, refer to Section 15-60.
2. Remove the extension housing seal using Seal Remover T71P-7657-A, or equivalent.



Installation

1. Install a new seal using Seal Replacer T71P-7095-A and Extension Housing Bushing Replacer T74P-7095-A, or equivalents.



2. Install the driveshaft. If necessary, refer to Section 15-60.

EXTENSION HOUSING BUSHING

SPECIAL SERVICE TOOLS REQUIRED:

Seal Remover	T71P-7657-A
Seal Replacer	T71P-7095-A
Extension Housing Bushing Replacer (Adapter used with T71P-7095-A)	T74P-7095-A
Bushing Remover	T77L-7697-E
Bushing Installer	T77L-7697-F
Bushing Replacer Adapter	T85M-7697-B

Removal

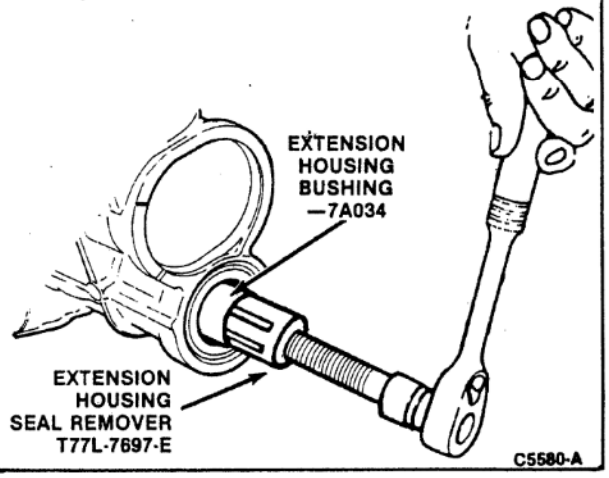
1. Remove the driveshaft. If necessary, refer to Section 15-60.
2. Remove the extension housing seal using Seal Remover T71P-7657-A, or equivalent. If necessary, refer to the procedure in this section.

REMOVAL AND INSTALLATION

EXTENSION HOUSING BUSHING

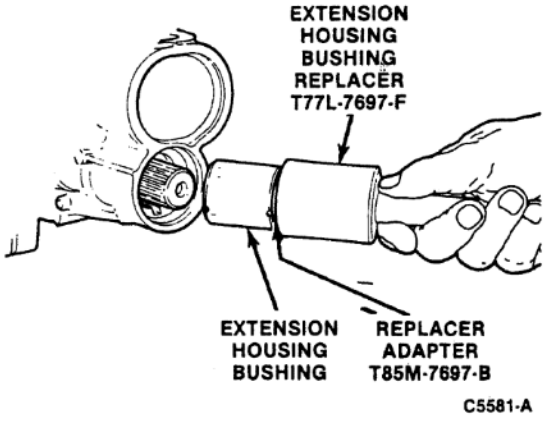
Removal (Continued)

3. Remove the extension housing bushing using Bushing Remover T77L-7697-E, or equivalent.

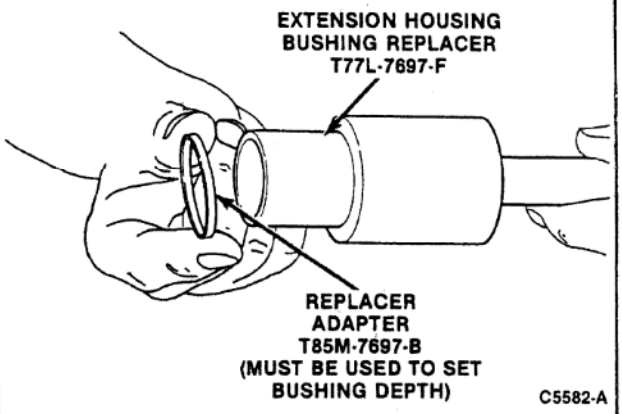


Installation

1. Install a new bushing using Bushing Replacer T77L-7697-F and Replacer Adapter T85M-7697-B, or equivalents.



NOTE: The replacer adapter must be used to set the bushing depth in the extension housing.



2. Install a new seal using Seal Replacer T74P-7095-A and Extension Housing Bushing Replacer T74P-7095-A, or equivalents. If necessary, refer to the procedure in this section.
3. Install the driveshaft. If necessary, refer to the procedure in Section 15-60.

SHIFT LEVER AND BOOT

Removal

1. Remove the shift knob.
2. Remove the console bezel attaching screws and bezel.
3. If equipped with power windows, raise the bezel, disconnect the wiring connectors from the power window switches and remove the bezel.
4. Remove the shift boot and foam insulator.
5. Remove the screws attaching the shift lever boot retainer to the floor pan and remove the retainer.
6. Remove the shift lever attaching screws using a No. 40 torx socket.
7. Remove the shift lever.

REMOVAL AND INSTALLATION

SHIFT LEVER AND BOOT

Installation

1. Position the shift lever and install the attaching bolts.

   Tighten the attaching bolts to 21 to 26 N·m (16 to 19 lb-ft).
2. Position the boot retainer and install the attaching screws. Tighten the attaching screws to 0.8–1.0 N·m (7 to 9 lb-in).
3. Install the shift lever boot and foam insulator.
4. If equipped with power windows, connect the wiring to the switches and position the console bezel.
5. Install the console bezel attaching screws.
6. Install the shift knob.

DISASSEMBLY AND ASSEMBLY

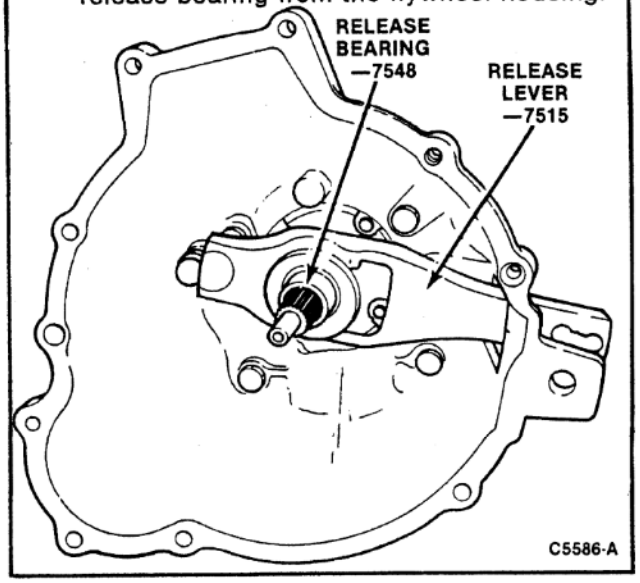
TRANSMISSION

SPECIAL SERVICE TOOLS REQUIRED:

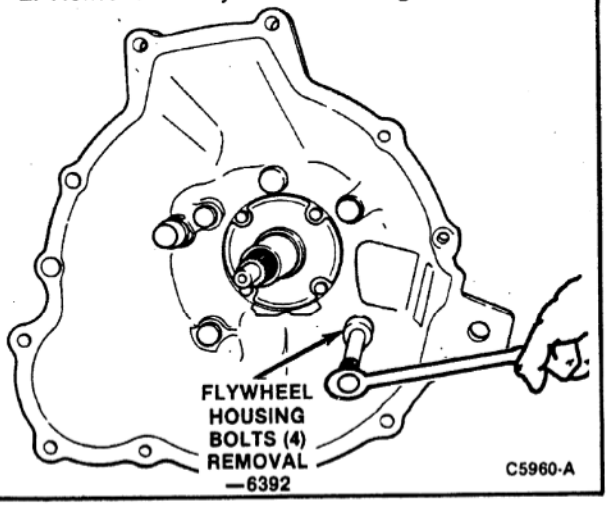
Holding Fixture	T57L-500-B
Dummy Shaft	T74P-7111-B
Puller	T71P-19703-B
Step Plate	D80L-630-A1
Fabricated Puller Using: — 7/8 in. Socket, 3/8 in. Drive — Flat Washer — M8 Nut — M8 × 1.25P × 66 mm Bolt	
Differential Cup Replacer	T77F-4222-A
Pinion Bearing Cone Remover	D79L-4621-A
Bearing Cone Remover	T71P-4621-B
Inner Race Remover	T75P-3504-G
Slide Hammer	T50T-100-A
Puller	T58L-101-A
Bearing Cone Replacer	T53T-4621-B
Axle Bearing/Seal Plate	T75L-1165-B
Center Bearings Replacer	T77J-7025-K
Pinion Bearing Cone Replacer	T62F-4621-A
Forcing Screw	T75L-7025-J
Step Plate	D80L-630-3
Adjustable Frame Press	T77J-7025-N
Bearing Replacer Tube	T77L-7025-C
Front Cover Aligner 36 mm or 1-7/16 inch 12 point socket	T57L-4621-B

Disassembly

1. Remove the clutch release lever and release bearing from the flywheel housing.



2. Remove the flywheel housing.

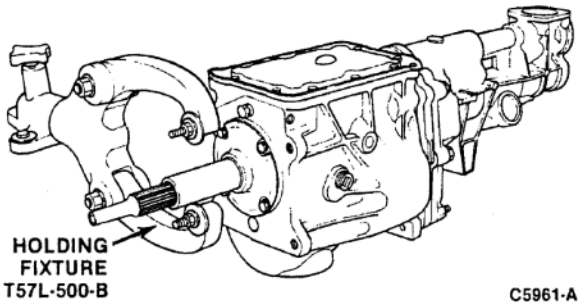


DISASSEMBLY AND ASSEMBLY

TRANSMISSION

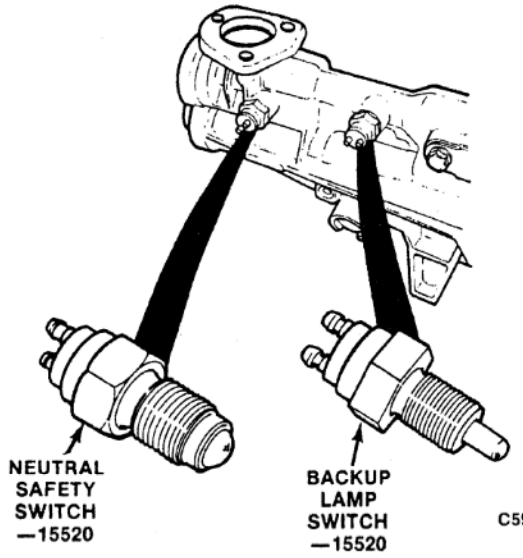
Disassembly (Continued)

3. Mount the transmission in Holding Fixture T57L-500-B, or equivalent, and remove the speedometer driven gear from the extension housing.



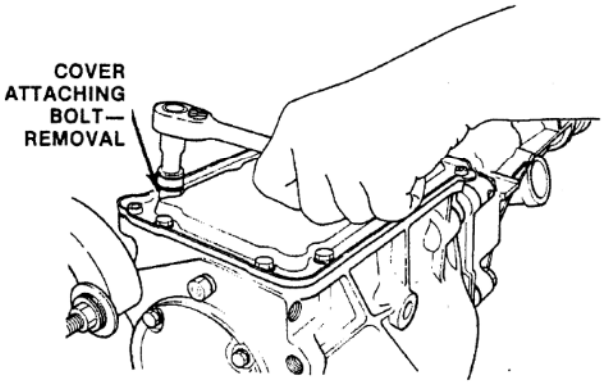
C5961-A

4. Remove the backup light switch and neutral safety switches from the extension housing.



C5962-A

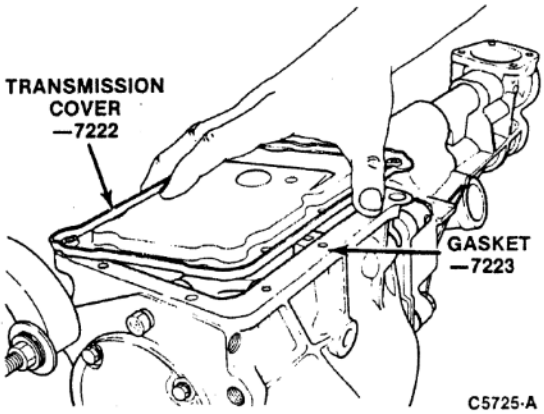
5. Remove the transmission cover attaching bolts.



C5589-A

6. Remove the transmission cover and gasket. Discard the gasket.

   Turn the transmission over and allow the oil to drain from the case into a suitable container.



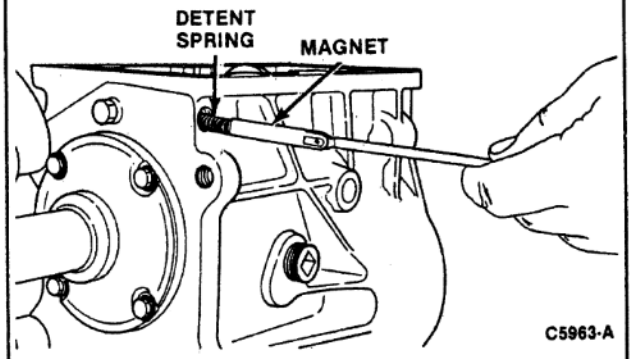
C5725-A

DISASSEMBLY AND ASSEMBLY

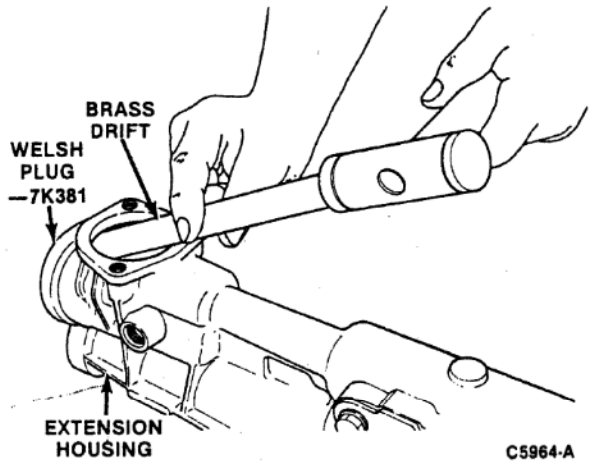
TRANSMISSION

Disassembly (Continued)

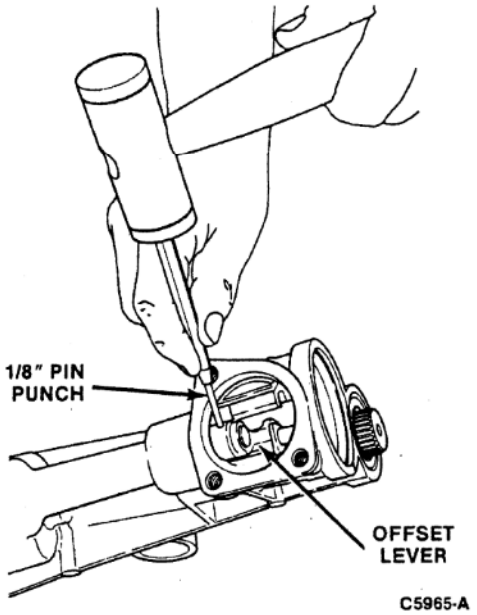
7. Remove the plug from the shift detent bore.
8. Using a small magnet, remove the detent spring and detent plunger.



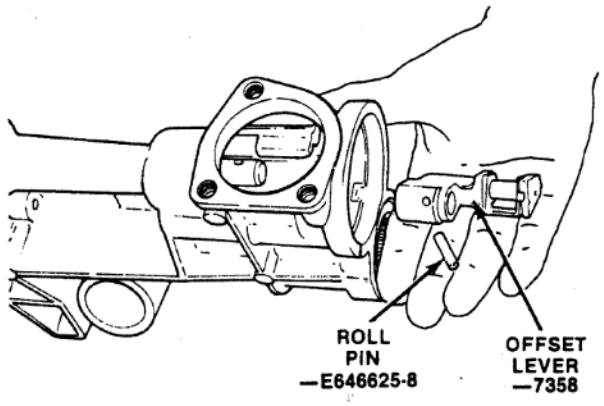
9. Using a brass drift and hammer, drive the welsh plug out of the extension housing.



10. Shift the transmission into reverse gear to gain access to the offset lever roll pin and remove the offset lever roll pin using a 1/8-inch pin punch.



11. Remove the offset lever and roll pin from the extension housing.

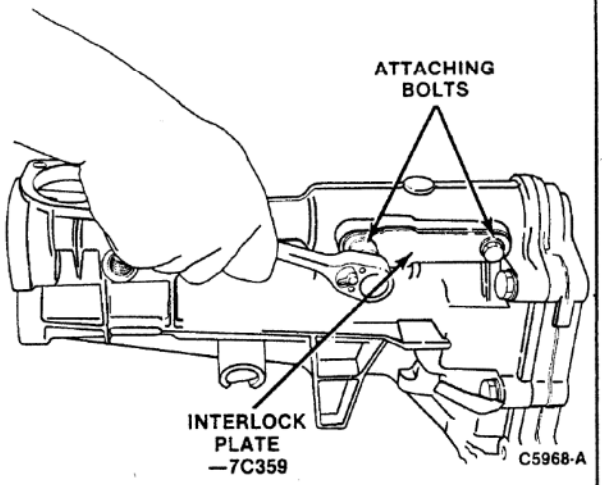


DISASSEMBLY AND ASSEMBLY

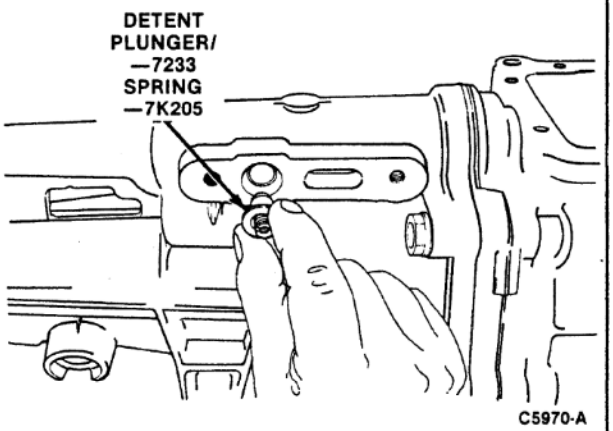
TRANSMISSION

Disassembly (Continued)

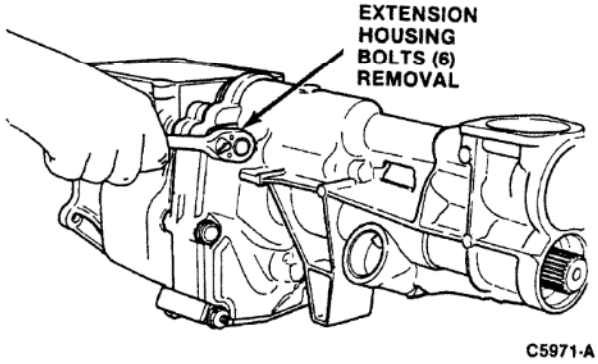
12. Remove the fifth-gear interlock plate attaching bolts.



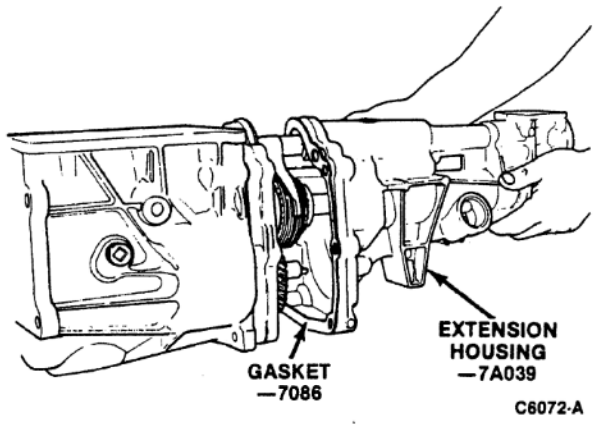
13. Remove the fifth-gear interlock plate, detent spring, and detent plunger.



14. Remove the extension housing attaching bolts.



15. Remove the extension housing and gasket. Discard the gasket.

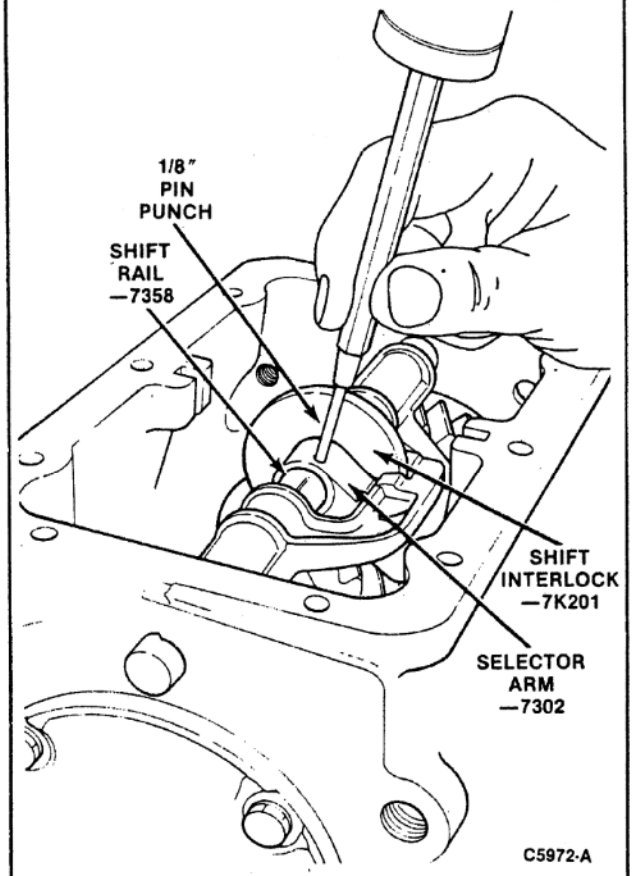


DISASSEMBLY AND ASSEMBLY

TRANSMISSION

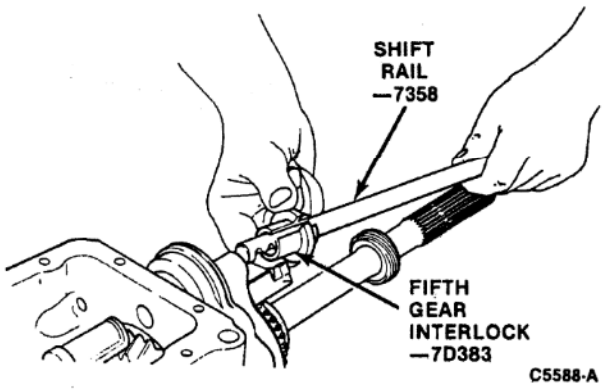
Disassembly (Continued)

16. Using a 1/8-inch pin punch and hammer, remove the shift rail roll pin.

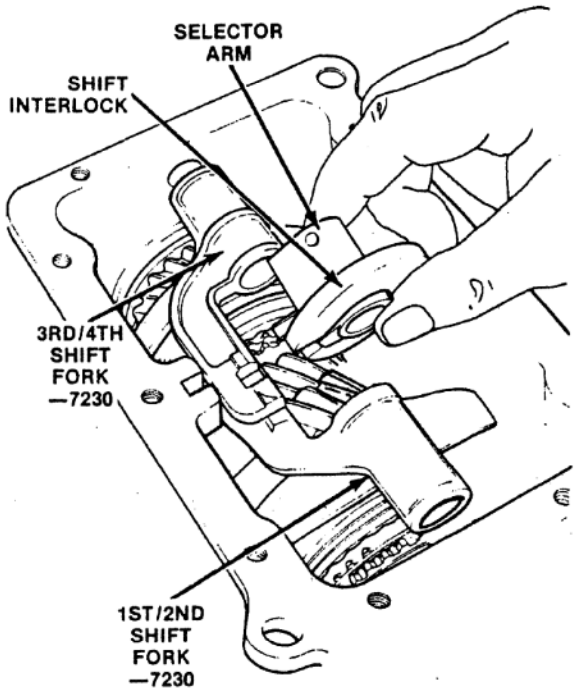


17. Remove the shift rail and the fifth-gear interlock.

    Pull the shifter shaft out of the transmission using a twisting motion.

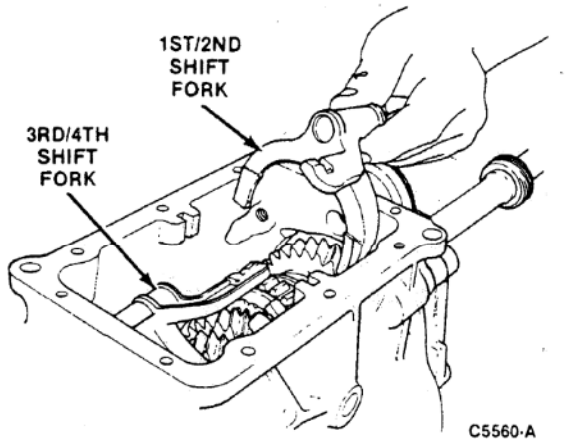


18. Remove the shift interlock for the first/second and third/fourth shift forks.

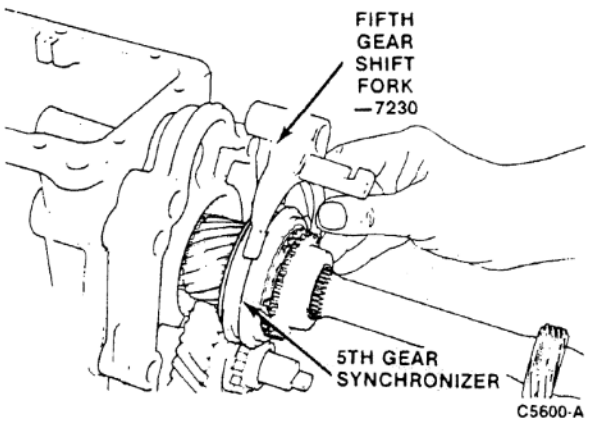


DISASSEMBLY AND ASSEMBLY (Continued)

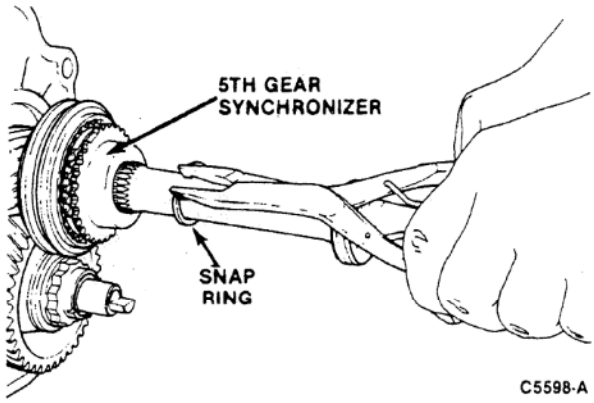
19. Remove the first/second and third/fourth shift forks.



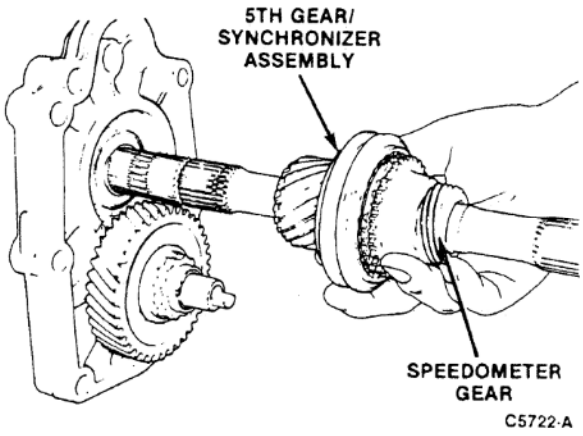
20. Remove the fifth-gear shift fork.



21. Remove the fifth-gear synchronizer snap ring.



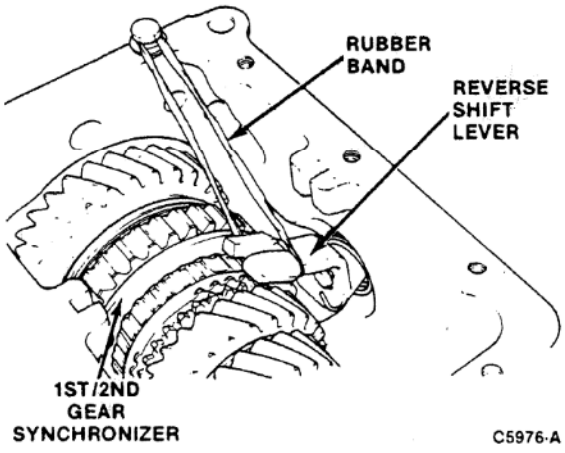
22. Slide the fifth gear and synchronizer assembly rearward until it stops against the speedometer gear.



DISASSEMBLY AND ASSEMBLY (Continued)

23. To prevent rotation of the mainshaft and cluster gear, shift the transmission into first and reverse gears.

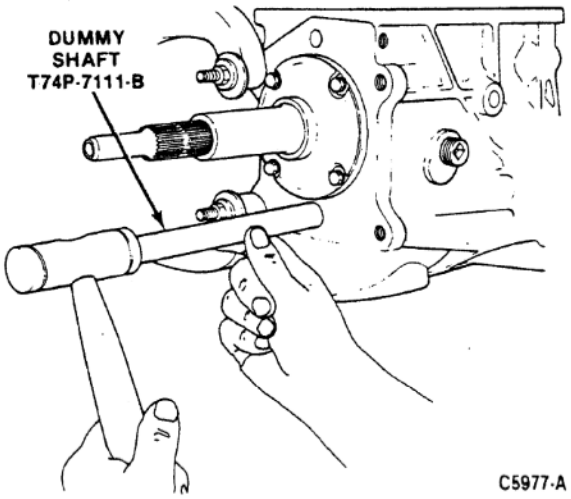
    To hold the reverse idler gear in position, stretch a rubber band from the reverse lever to a cover bolt screwed into the transmission case.



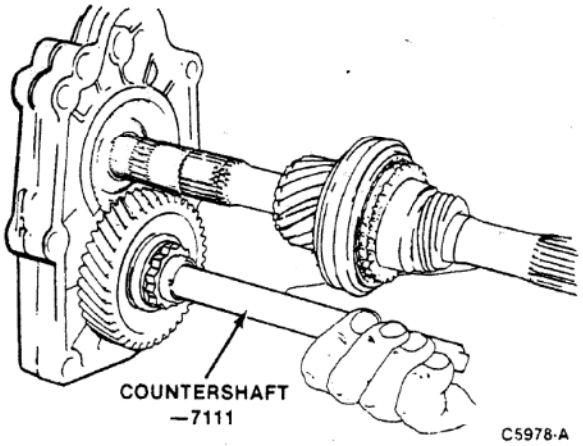
NOTE: The cover bolt can remain in place because it will also be needed during assembly of the transmission.

NOTE: Steps 24 and 25 are NOT required for 1987 and later model units. Go directly to Step 26 for such models.

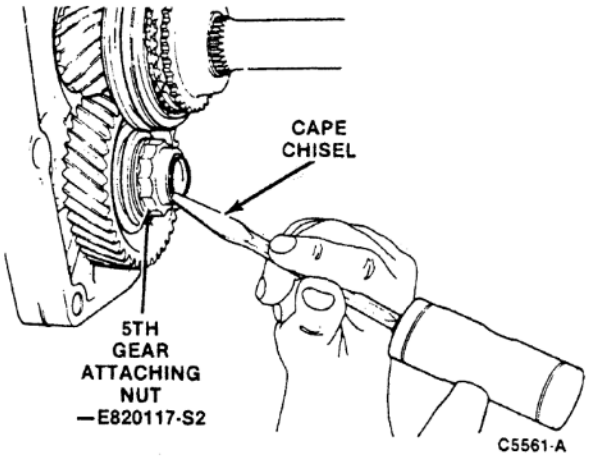
24. Partially install Dummy Shaft T74P-7111-B, or equivalent, through the front of the case to support the cluster gear during removal of the fifth gear.



25. Pull the countershaft out of the cluster gear from the rear, allowing the dummy shaft to follow the countershaft. Do not allow the dummy shaft to move any further into the case than the point where its end is flush with the front exterior face of the case.

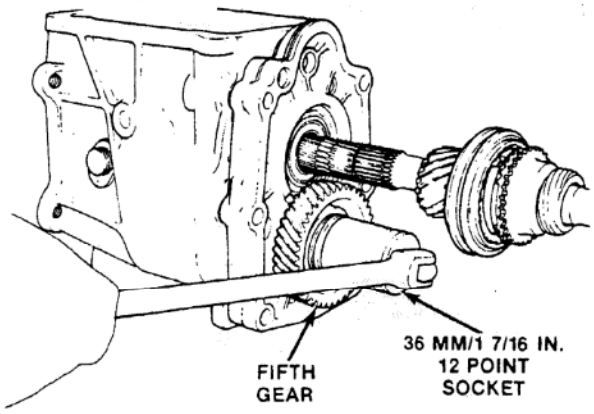


26. Remove the staking from the fifth-gear attaching nut.

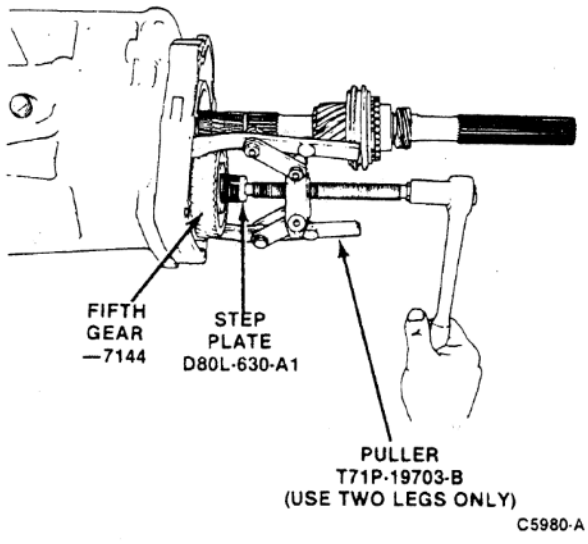


DISASSEMBLY AND ASSEMBLY (Continued)

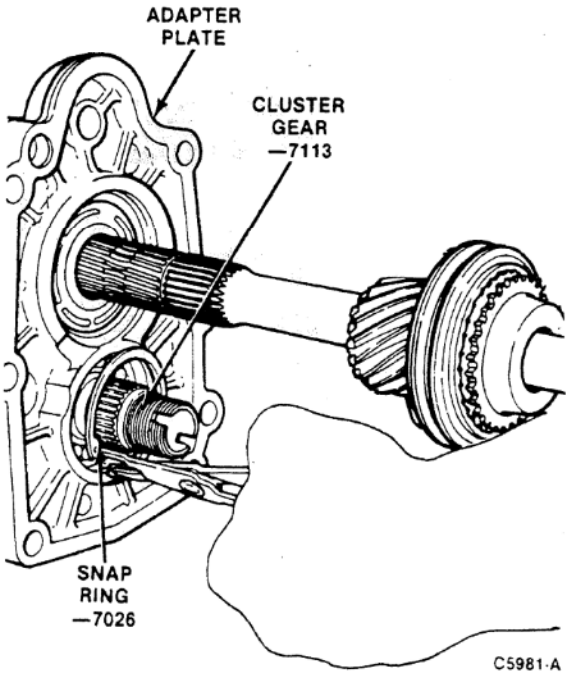
27. Using a 36mm or 1-7/16 inch 12-point socket, remove the fifth-gear attaching nut.



28. Remove the fifth gear using Puller T71P-19703-B with two legs and Step Plate D80L-630-A1. Be sure the puller jaws are fully engaged with the underside of the gear.

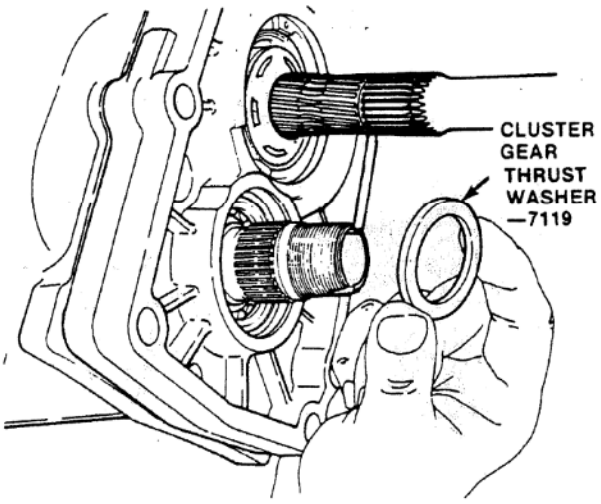


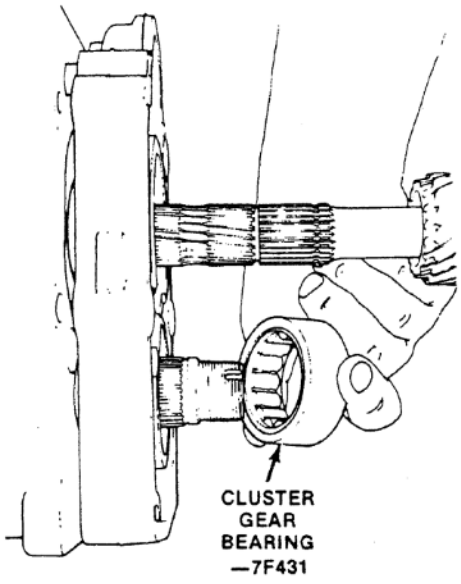
29. Remove the cluster gear rear bearing snap ring from the adapter plate.



DISASSEMBLY AND ASSEMBLY (Continued)

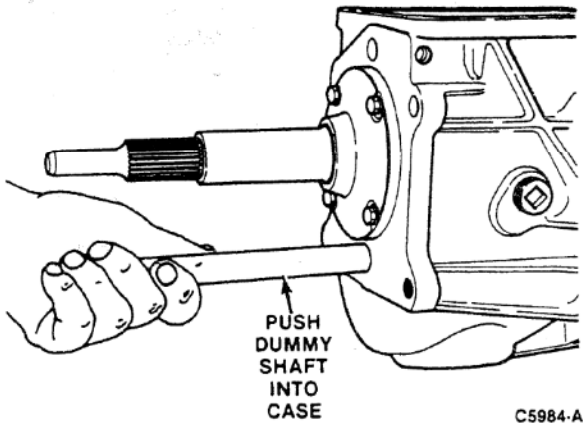
30. Remove the cluster gear rear bearing and thrust washer when they drop out of the adapter plate.



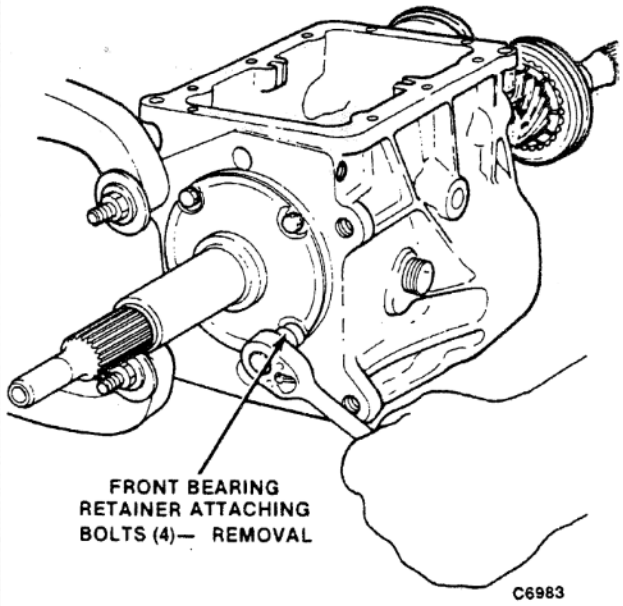


NOTE: Step 31 is NOT required for 1987 and later model units. Go directly to Step 32 for such models.

31. Push the dummy shaft rearward until it just clears the front of the transmission case and allows the cluster gear to drop into the bottom of the case.

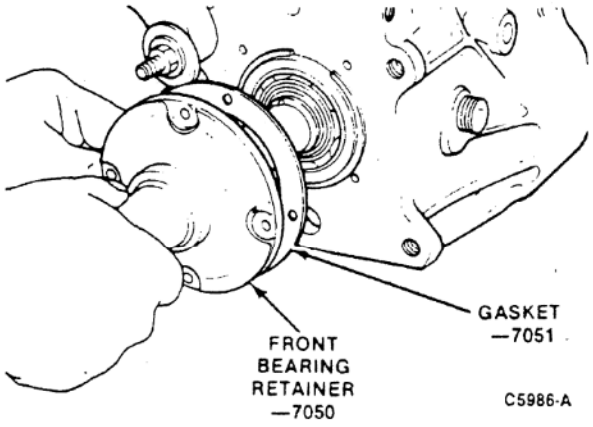


32. Remove the front bearing retainer attaching bolts.

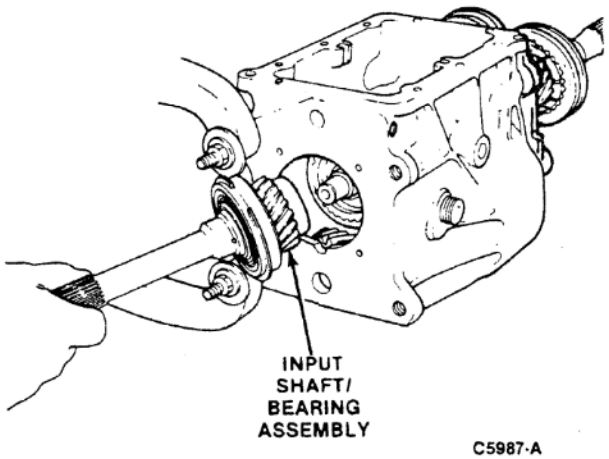


DISASSEMBLY AND ASSEMBLY (Continued)

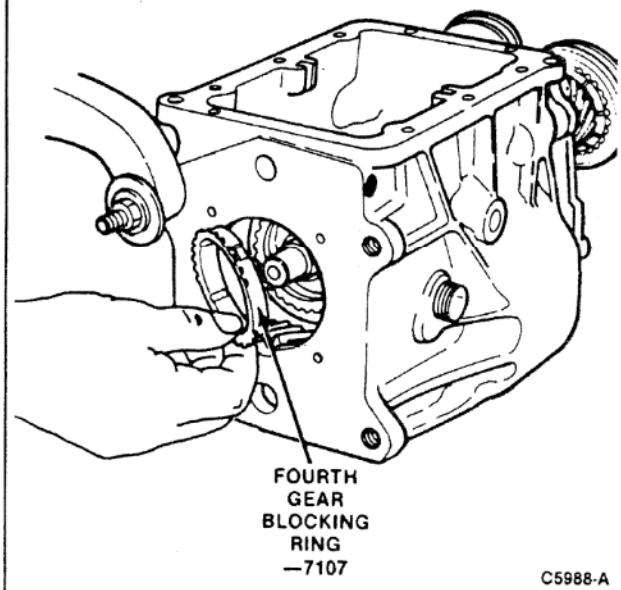
33. Remove the bearing retainer and gasket. Discard the gasket.



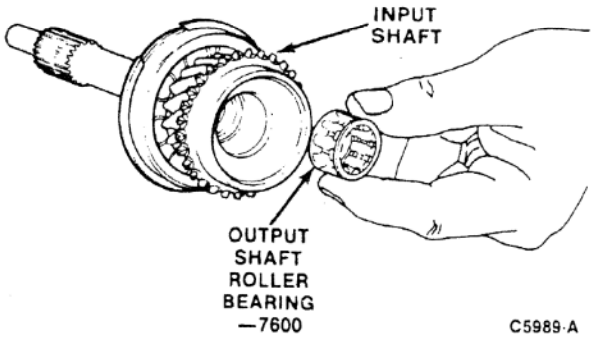
34. Remove the input shaft and bearing as an assembly.



35. If the fourth-gear blocking ring does not come out with the input shaft, reach into the case and remove it from the third/fourth gear synchronizer.

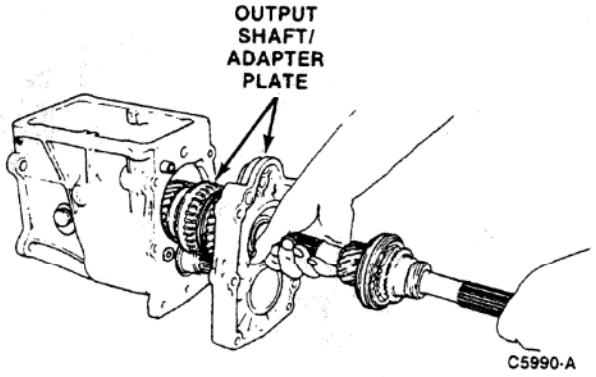


36. Remove the output shaft front roller bearing from the input shaft.

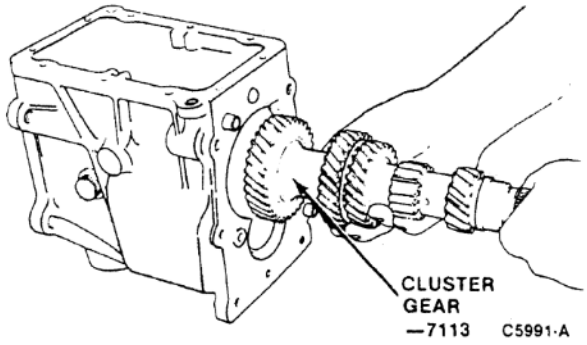


DISASSEMBLY AND ASSEMBLY (Continued)

37. Remove the output shaft and adapter plate as an assembly through the rear of the case.
    Remove and discard the adapter plate gasket.

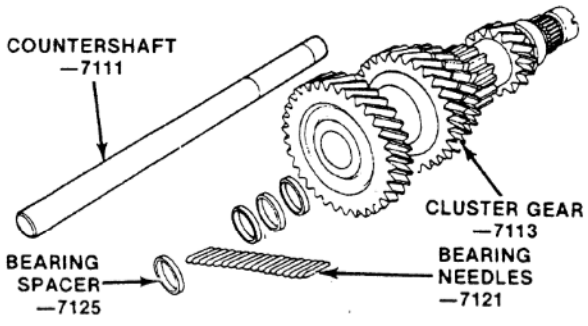


38. Remove the cluster gear.

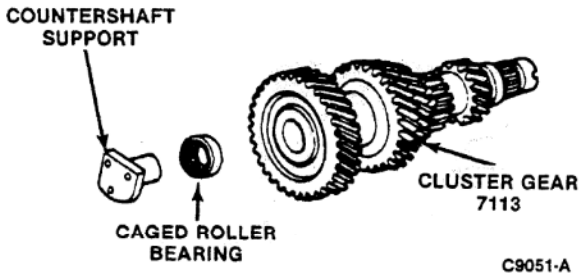


NOTE: Step 39 is NOT required for 1987 and later model units. Go directly to Step 40 for such models.

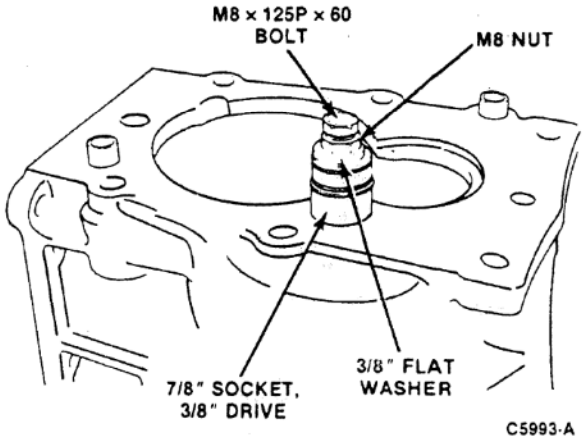
39. Remove the dummy shaft from the cluster gear. Carefully remove the spacers and bearing needles from the front end of the cluster gear.



40. For 1987 and later models, remove caged roller bearing using a hammer and sharp chisel.

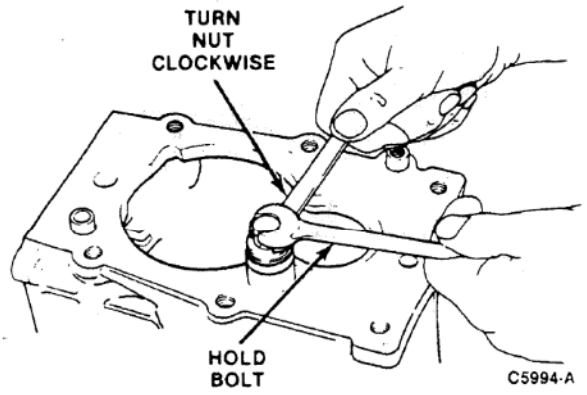


41. Fabricate a puller using:
    - 3/8-inch drive, 7/8-inch socket
    - Flat washer
    - M8 X 125P nut
    - M8 X 125P X 60mm bolt

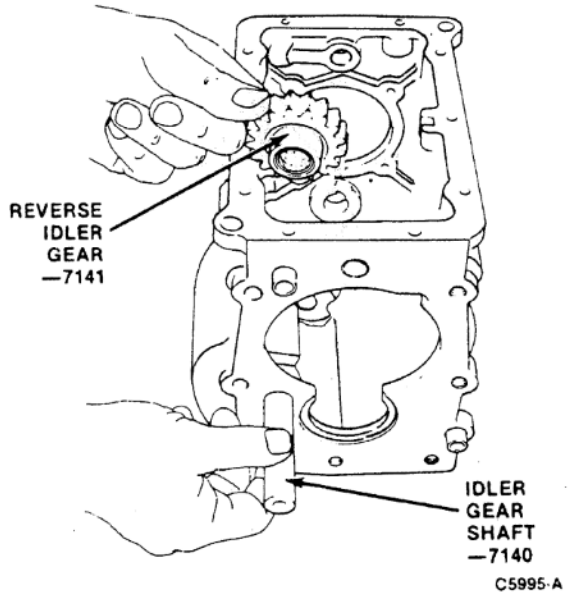


DISASSEMBLY AND ASSEMBLY (Continued)

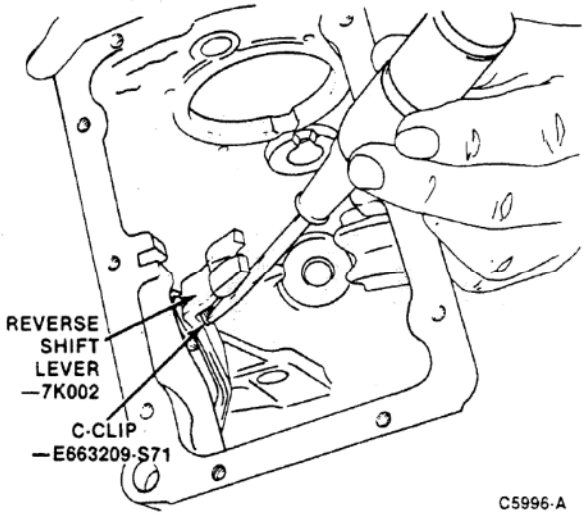
42. Assemble the puller and turn the nut clockwise to remove the reverse idler gear shaft.



43. Remove the reverse idler gear and shaft.

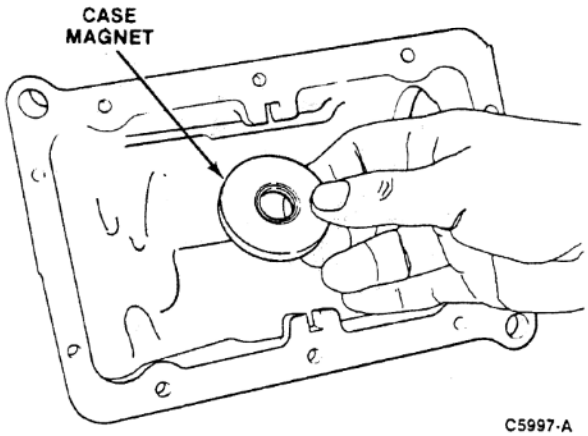


44. Remove the C-clip attaching the reverse lever to the lever pivot pin.



45. Remove the reverse shift lever and return spring from the pivot pin.

46. Remove the magnet from the case. Do not drop the magnet. It is ceramic and easily broken.

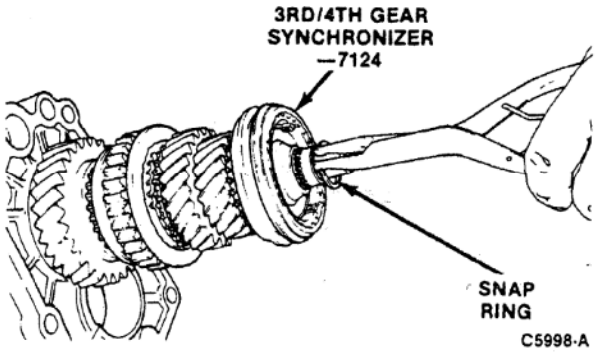


DISASSEMBLY AND ASSEMBLY (Continued)

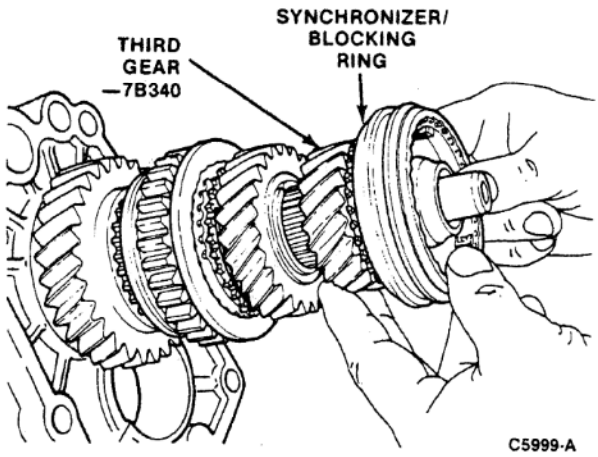
Output Shaft

Disassembly

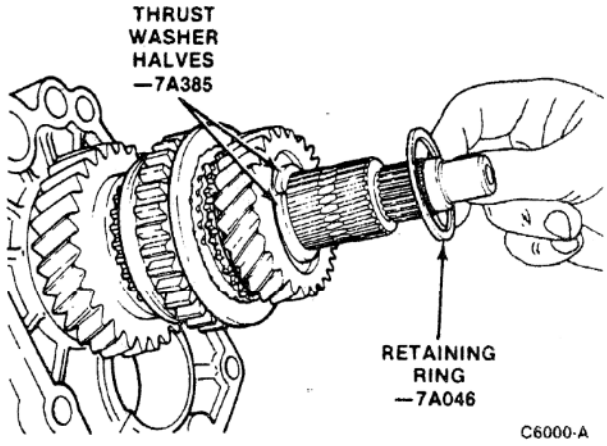
1. Remove the snap ring retaining the third/fourth gear synchronizer.



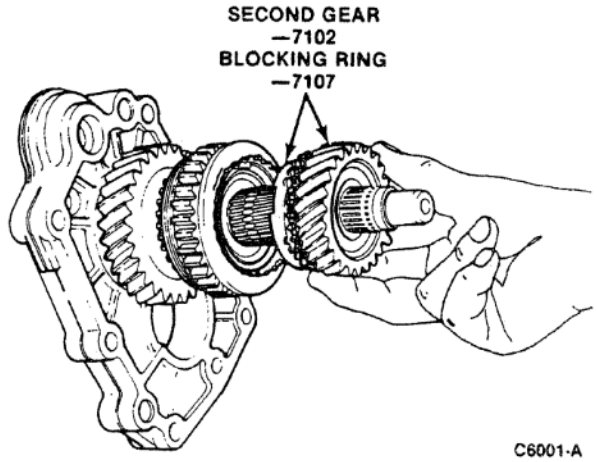
2. Remove the third/fourth synchronizer, third-gear blocking ring and third gear as an assembly.



3. Remove the retaining ring and thrust washer halves.



4. Remove second gear and the second-gear blocking ring.



NOTE: A snap ring is installed on the second gear to prevent synchronizer overtravel. If necessary remove the snap ring from the gear.

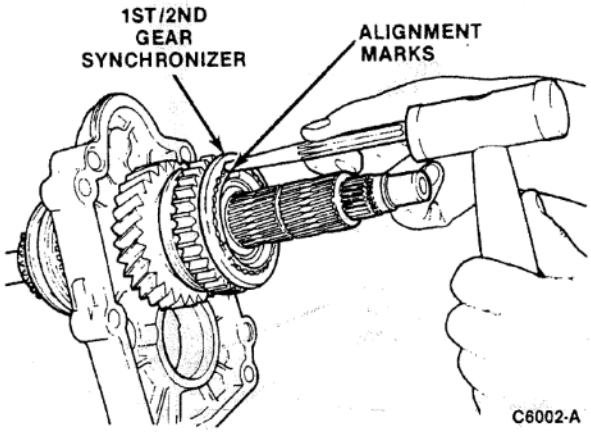
DISASSEMBLY AND ASSEMBLY

OUTPUT SHAFT

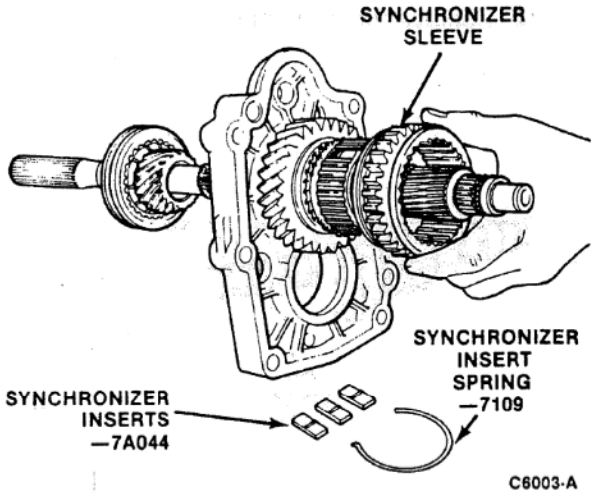
Disassembly (Continued)

5. Make an alignment mark on the first/second synchronizer sleeve and hub.

NOTE: The synchronizer sleeve and hub are matched during manufacture and should be reassembled in the exact same position. The marks will provide the necessary alignment reference during assembly.

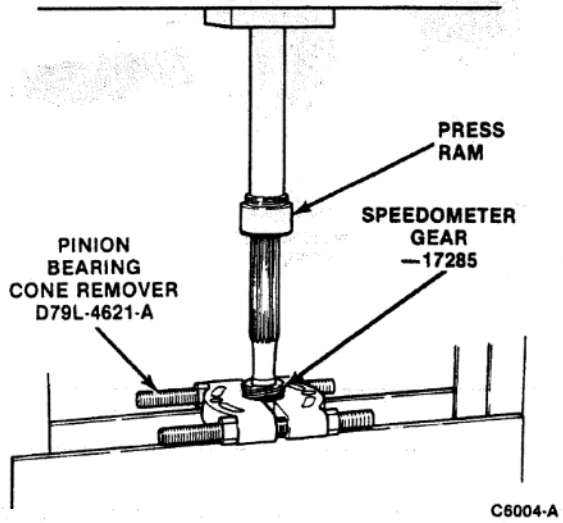


6. Remove the first/second synchronizer sleeve, inserts, and spring.

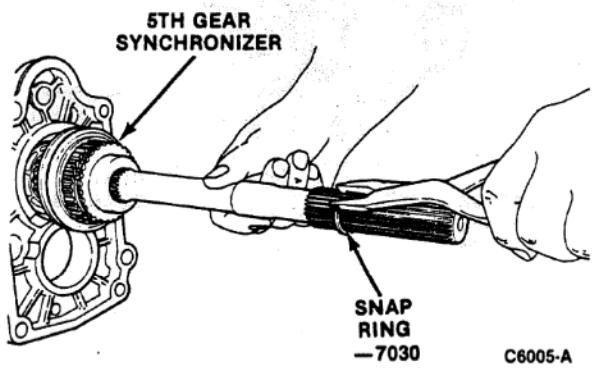


7. Mark the positon of the speedometer gear on the output shaft and remove the gear using a press and Pinion Bearing Cone Remover D79L-4621-A, or equivalent.

NOTE: The first/second synchronizer hub cannot be removed from the output shaft. If the hub or sleeve is damaged or worn, the synchronizer and shaft will have to be replaced as an assembly. The synchronizer springs and inserts are available separately for service replacement.



8. Remove the fifth-gear synchronizer snap ring from the output shaft.

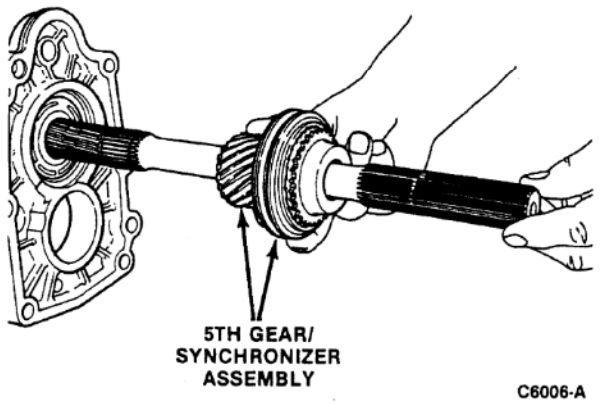


DISASSEMBLY AND ASSEMBLY

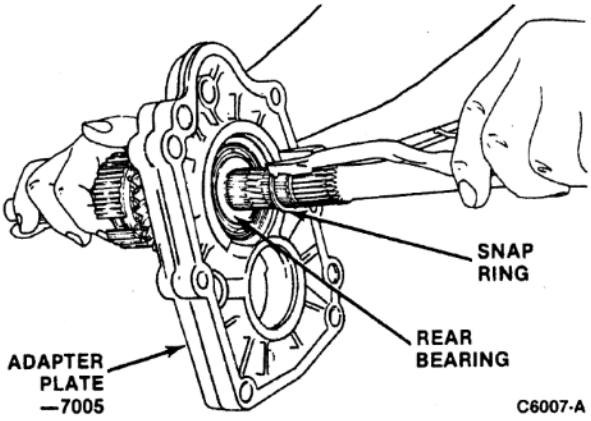
OUTPUT SHAFT

Disassembly (Continued)

9. Remove the fifth gear and synchronizer assembly.

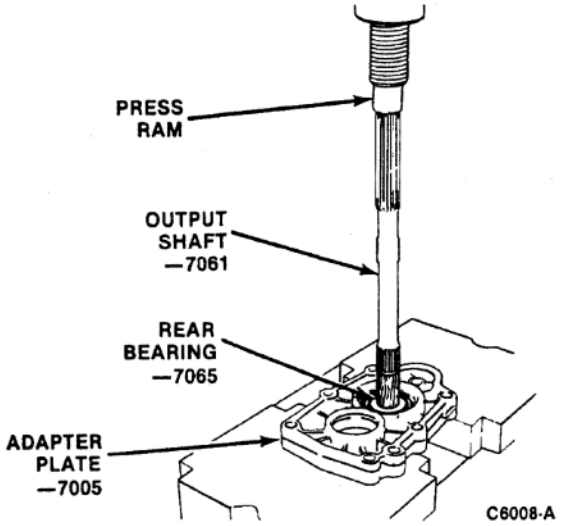


10. Remove the output shaft rear bearing snap ring.

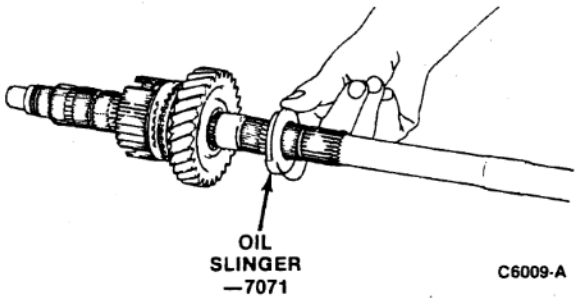


11. Press the output shaft out of the rear bearing.

NOTE: Be sure the adapter plate and bearing are properly supported before pressing on the shaft. Failure to provide proper support could damage the bearing and plate.



12. Remove the oil slinger.

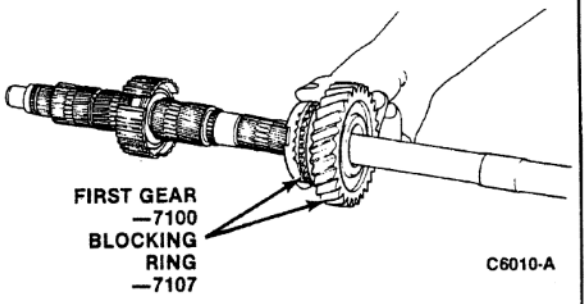


DISASSEMBLY AND ASSEMBLY

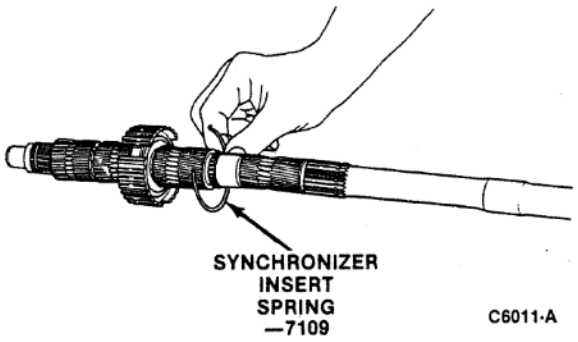
OUTPUT SHAFT

Disassembly (Continued)

13. Remove the first-gear synchronizer and blocking ring.



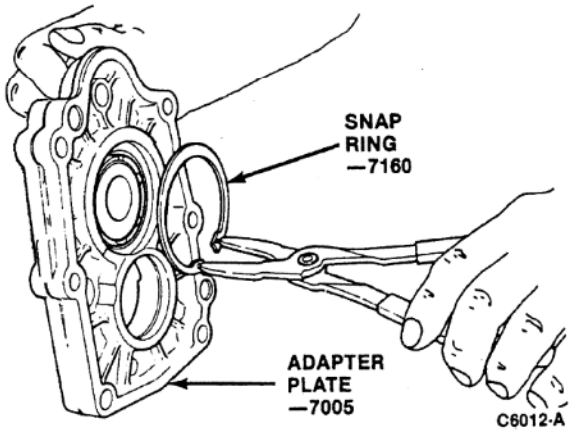
14. Remove the synchronizer insert spring.



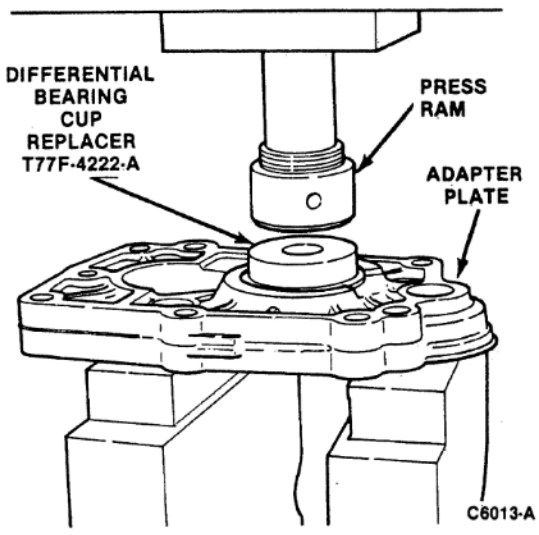
OUTPUT SHAFT BEARING

Removal

1. Remove the snap ring from the adapter plate.



2. Remove the bearing using a press and Differential Cup Replacer T77F-4222-A, or equivalent.

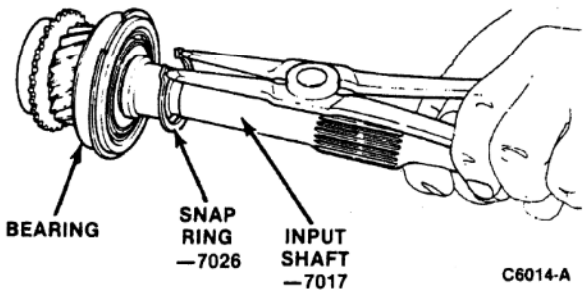


DISASSEMBLY AND ASSEMBLY

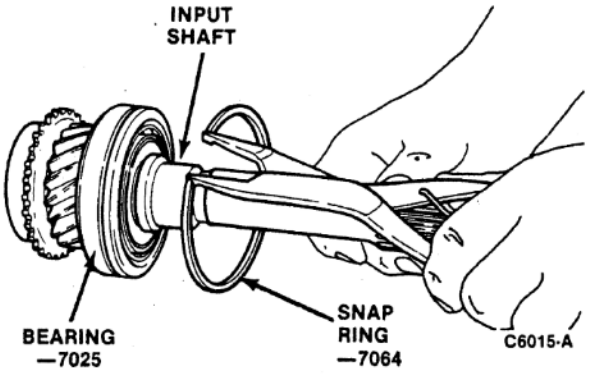
INPUT SHAFT BEARING

Removal

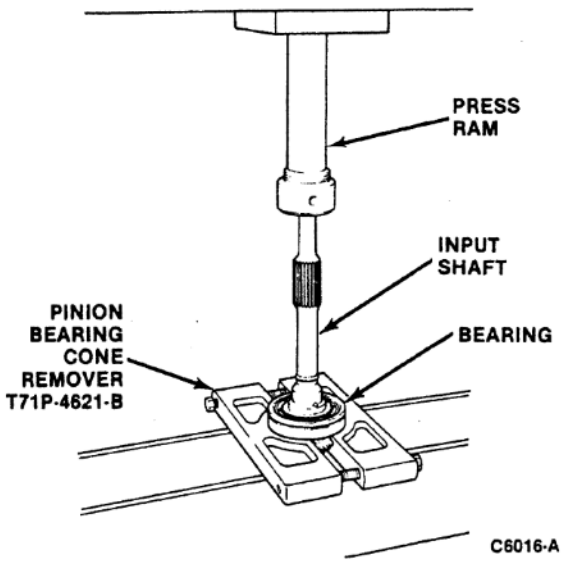
1. Remove the snap ring from the input shaft.



2. Remove the snap ring from the bearing.



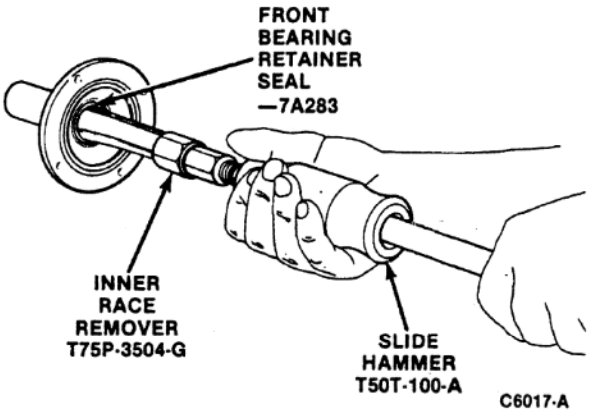
3. Remove the bearing using Bearing Cone Remover T71P-4621-B, or equivalent, and a press. Make sure the bearing inner race is fully supported.



FRONT BEARING RETAINER SEAL

Removal

1. Remove the front bearing retainer seal using Inner Race Remover T75P-3504-G and Slide Hammer T50T-100-A, or equivalent.

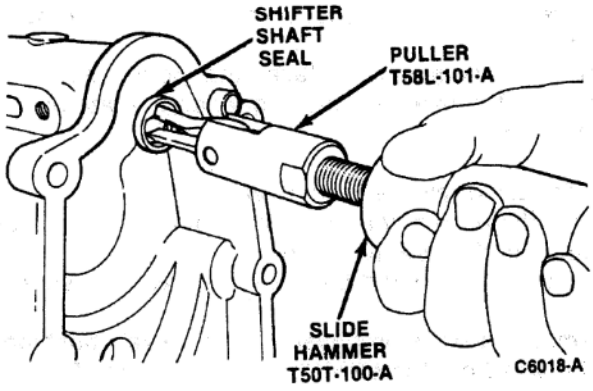


DISASSEMBLY AND ASSEMBLY

SHIFTER SHAFT SEAL

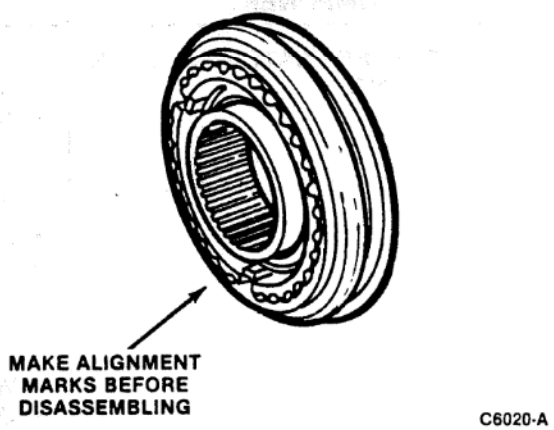
Removal

1. Remove the shifter shaft seal from the extension housing using Puller T58L-101-A and Slide Hammer T50T-100-A, or equivalent.



NOTE: The shifter shaft bushing is not serviced separately. If the bushing is damaged or worn, replace the extension housing.

NOTE: Before disassembling a synchronizer, make an alignment mark on the hub and sleeve. The synchronizer sleeve and hub are matched during manufacture and should be reassembled in the exact same position. The marks will provide the necessary alignment reference.

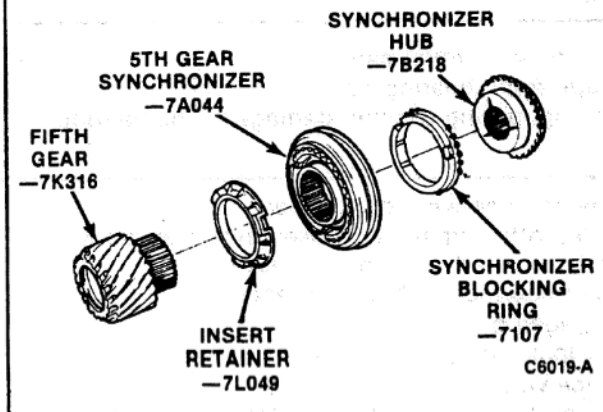


2. Using a small screwdriver, remove the insert springs and inserts.

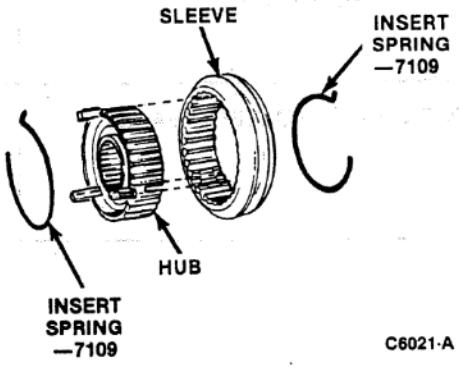
SYNCHRONIZER

Disassembly

1. Remove the hub, blocking ring, insert retainer and fifth gear from the fifth-gear synchronizer.



3. Slide the hub out of the sleeve.



DISASSEMBLY AND ASSEMBLY

COMPONENT INSPECTION CHART
MANUAL TRANSMISSION

NOTE: Before inspecting the transmission components, wash them thoroughly in cleaning solvent and dry with compressed air.

COMPONENT	CHECK FOR
CASE, ADAPTER PLATE AND EXTENSION HOUSING	• Threaded holes that are stripped, cross threaded or otherwise damaged • Nicks or burrs on the machined faces that could cause misalignment of the flywheel housing, adapter plate or extension housing • Cracks • A loose or damaged reverse shift lever pivot pin • Evidence that the output shaft or cluster gear ball bearings may have spun in the adapter plate • Evidence that the input shaft ball bearing may have spun in the case • Worn or damaged extension housing shifter shaft bushing • Oversized bores where the countershaft, shifter shaft and reverse idler shaft enter the case
INPUT SHAFT	• Scoring or galling of the pilot bearing surface • Worn, nicked or broken clutch plate splines • Worn, chipped or cracked gear teeth • Evidence that the ball bearing inner race has spun on the shaft • Scoring or pitting in the shaft seal area • Worn (rounded off), chipped or broken synchronizer teeth • Worn or rough roller bearing bore • Worn, galled or scored blocking ring taper
BEARING RETAINER	• Scored, worn or pitted release bearing surface • Cracks • Damaged seal bore
INPUT SHAFT ROLLER BEARING	• Bent, broken or worn roller cage • Worn or rough roller bearing bore • Scoring, galling, pitting or other damage to the bearing rollers
GEARS	• Chipping, galling and wear on each gear tooth • Worn (rounded off), chipped or broken synchronizer teeth • Worn, galled or scored blocking ring taper • Roughness or scoring on thrust surfaces • Worn or damaged bore • Damaged or loose speedometer gear • Thrust surface wear • Heavy grooving or glazing of synchronizer cone surface

CC5692-A

DISASSEMBLY AND ASSEMBLY

COMPONENT INSPECTION CHART
MANUAL TRANSMISSION (Continued)

COMPONENT	CHECK FOR
OUTPUT SHAFT	• Scored, galled or worn gear surfaces • Worn, nicked or broken synchronizer splines • Evidence that the ball bearing inner race has spun on the shaft • Worn, nicked or broken slip yoke splines • Scoring or galling of the roller bearing pilot • Loose or damaged first/second synchronizer hub • Damaged snap ring grooves • Restricted lubrication holes • Cracks • Bent or twisted condition
CLUSTER GEAR AND COUNTERSHAFT	• Chipping, galling and wear on each gear tooth • Evidence that the ball bearing inner race has spun on the shaft • Bent condition • Damaged threads • Scored, galled or worn shaft surfaces • Worn or rough needle bearing bore
COUNTERSHAFT NEEDLE BEARINGS	• Scoring, galling, pitting or other damage to the needle bearings. Always replace the bearings as a set.
SNAP RING	• Loss of tension • Bent or twisted condition • Worn snap ring surface
SHIFT RAIL AND SHIFT FORKS	• Bent shift rail • Damaged shift rail roll pin holes • Damaged offset lever • Worn, cracked or damaged shift forks • Worn offset lever bushing
SHIFT INTERLOCKS AND DETENTS	• Worn detent plunger • Loss of detent plunger spring tension • Damaged selector roll pin, pin hole or shaft • Worn or damaged interlock "C" plate • Worn, bent or broken fifth-gear lock plate • Damaged fifth-gear interlock springs, selector pin, bushing or plunger

CC5692-A

DISASSEMBLY AND ASSEMBLY

COMPONENT INSPECTION CHART
MANUAL TRANSMISSION (Continued)

COMPONENT	CHECK FOR
REVERSE SHIFT LEVER AND SHAFT	• Bent, broken or cracked reverse shift lever • Loss of return spring tension • Worn or bent pivot pin • Loss of retaining clip tension • Worn or broken shift fork • Worn or scored reverse gear shaft
SYNCHRONIZERS AND BLOCKING RINGS	• First/second synchronizer hub loose on output shaft • Worn synchronizer inserts • Loss of insert spring tension • Damaged insert springs • Rounded teeth on the synchronizer hub and sleeve • Chips or burrs on the synchronizer teeth • Worn or damaged synchronizer hub splines • Worn or scored shift fork groove • Widened blocking ring slots • Rounded blocking ring teeth • Cracked blocking ring • Worn blocking ring — Inside taper should show fine grooves. — To check for wear, position the blocking ring on the matching gear taper, rotate it until it stops and check the ring-to-ring clearance. Clearance should be 0.7 mm minimum (0.028 in.).
BALL BEARINGS	• Lubricate bearing raceways with a slight amount of clean transmission oil. Turn the bearing back and forth slowly until the races and balls are coated. • Hold bearing by inner ring in a vertical position. Vertical movement between inner and outer rings is acceptable. Spin outer ring several times by hand (do not use an air hose). If roughness or vibration is noticeable or outer ring stops abruptly, the bearing should be cleaned again and relubricated. Roughness in a bearing is usually caused by foreign particles in the bearing, which come from inside the transmission case. If bearing is still rough after cleaning and relubricating three times, it must be replaced. • Hold bearing by inner ring in a horizontal position with snap ring groove up. Spin outer ring several times by hand (do not use an air hose). If the bearing is still rough after cleaning and relubricating three times (if not done in Step 2), it must be replaced. If the bearing passes the visual inspection and spin tests, it should be reinstalled in the transmission.

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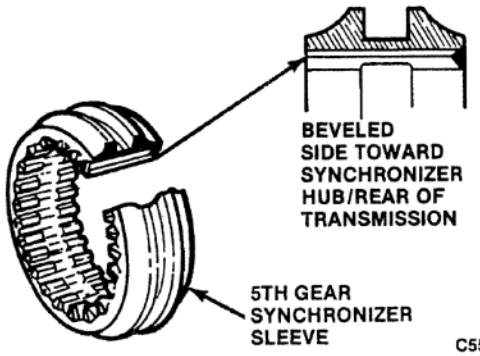
DISASSEMBLY AND ASSEMBLY

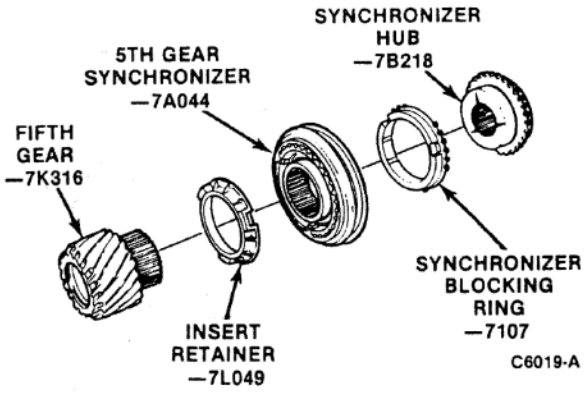
SYNCHRONIZER

Assembly

1. Align the reference marks made during disassembly and slide the synchronizer sleeve over the hub.

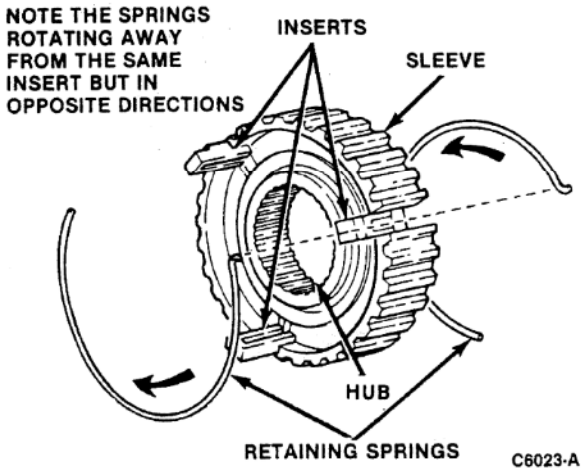
CAUTION: When assembling the fifth gear synchronizer, make sure the beveled side of the synchronizer sleeve faces the synchronizer hub.





NOTE: The sleeve and hub have an extremely close fit and must be held square during assembly to prevent jamming. Do not force the sleeve onto the hub.

2. Install the inserts and springs. The hooked end of the springs engage the same insert but rotate away from the insert in opposite directions.

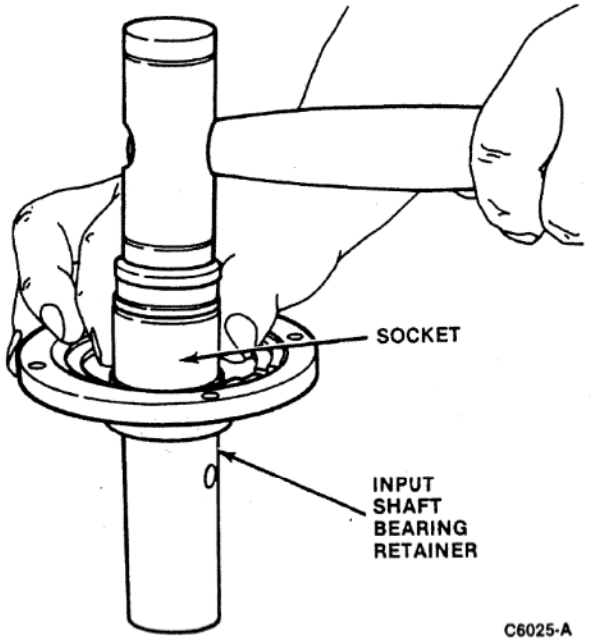


3. Install the insert retainer, gear, blocking ring, and hub in the fifth-gear synchronizer.

FRONT BEARING RETAINER SEAL

Installation

1. Install the front bearing retainer seal, using a socket of suitable size.

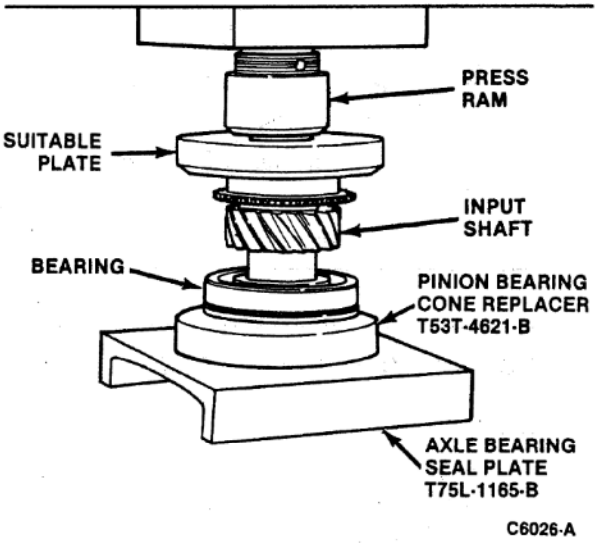


DISASSEMBLY AND ASSEMBLY

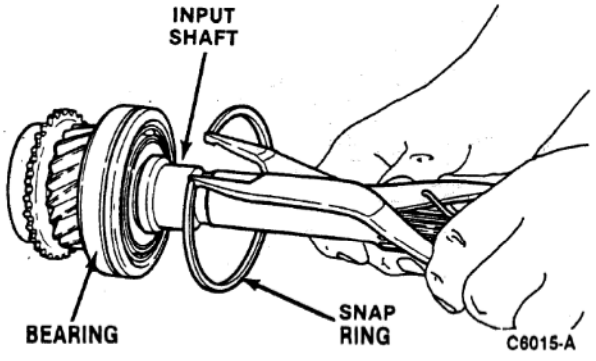
INPUT SHAFT BEARING

Installation

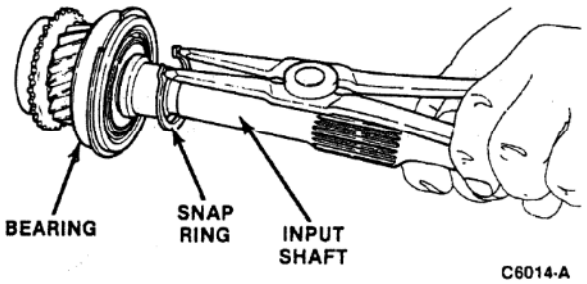
1. Install the input shaft bearing using a Press Pinion Bearing Cone Replacer T53T-4621-B and Axle Bearing Seal Plate T75L-1165-B, or equivalents. To prevent damage to the synchronizer taper or bearing bore, place a suitable plate between the press ram and the input shaft.



2. Install the snap ring on the bearing.



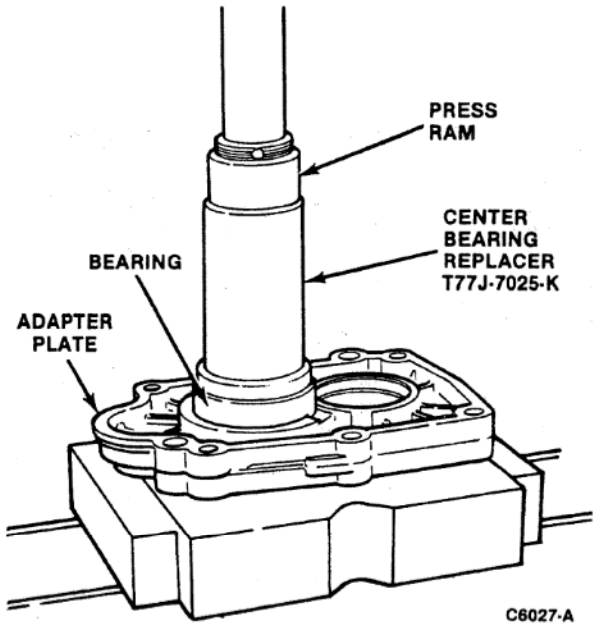
3. Install a new selective snap ring on the input shaft.



OUTPUT SHAFT BEARING

Installation

1. Install the output shaft rear bearing in the adapter plate, using a press and Center Bearing Replacer T77J-7025-K, or equivalent.

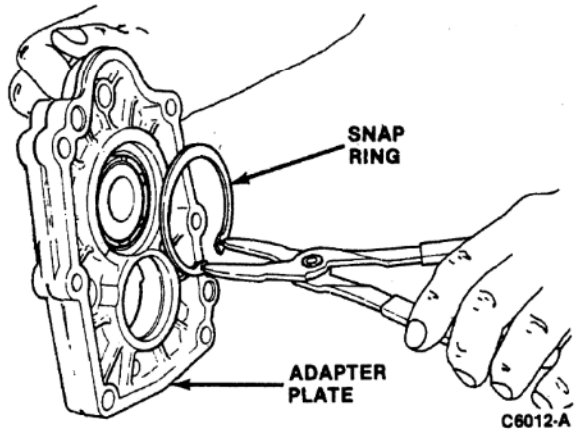


DISASSEMBLY AND ASSEMBLY

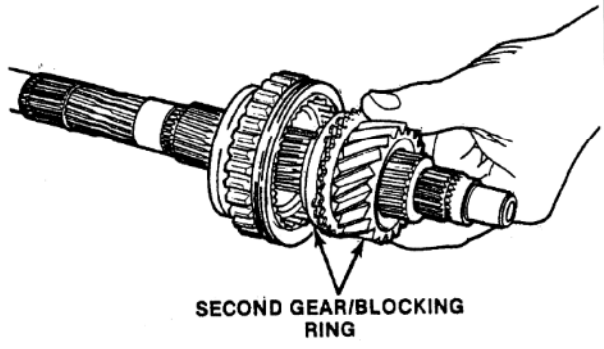
OUTPUT SHAFT BEARNG

Installation (Continued)

2. Install a new selective snap ring in the adapter plate bore.



2. Install the second gear blocking ring and second gear.



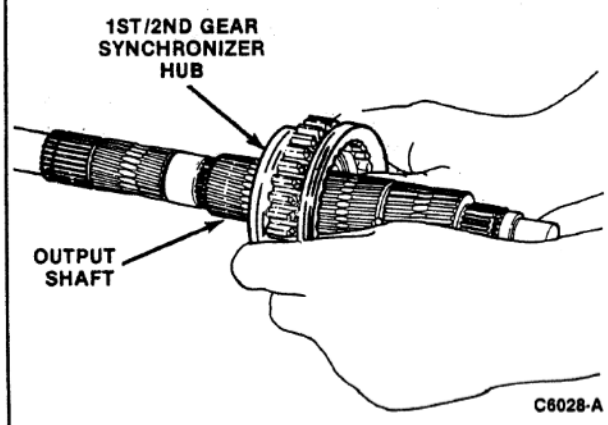
NOTE: Make sure the snap ring is in position before installing second gear.

OUTPUT SHAFT

Assembly

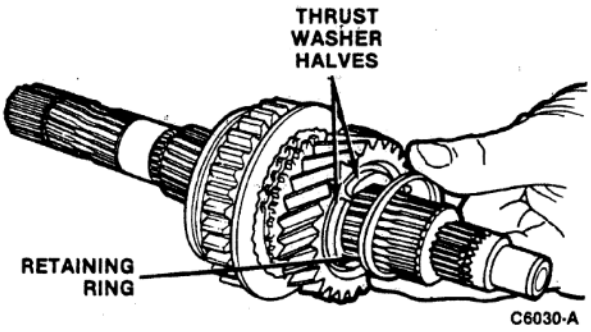
1. Assemble the first/second synchronizer.

NOTE: Be sure the shift fork groove faces the front of the output shaft as viewed in its assembled position in the transmission.



3. Install the thrust washer halves and the retaining ring.

NOTE: Be sure the thrust with the tang engages the hole in the output shaft.

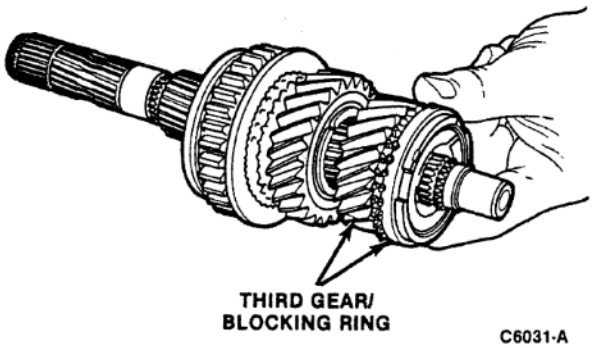


DISASSEMBLY AND ASSEMBLY

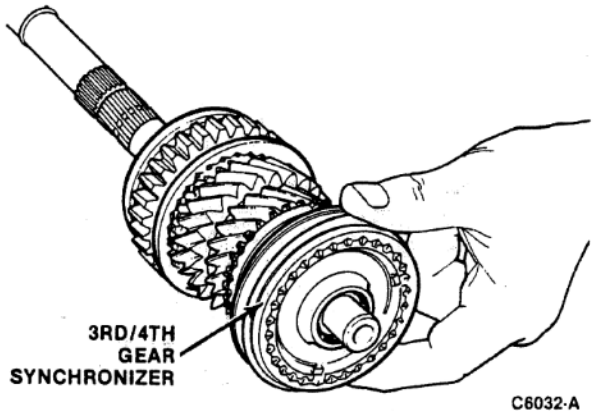
OUTPUT SHAFT

Assembly (Continued)

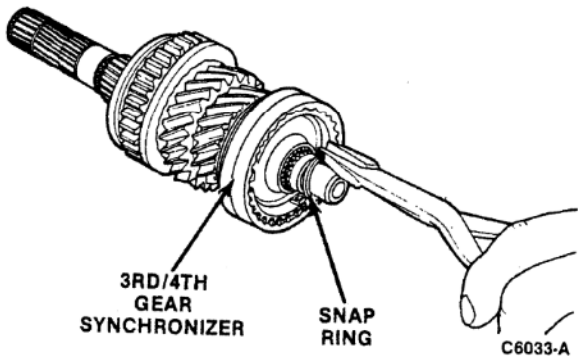
4. Install third gear and the third-gear blocking ring.



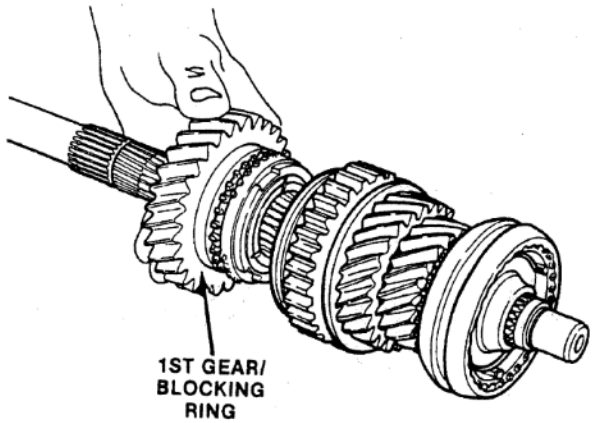
5. Install the third/fourth synchronizer.



6. Install a new selective fit third/fourth synchronizer snap ring.



7. Install the first-gear blocking ring and first gear.

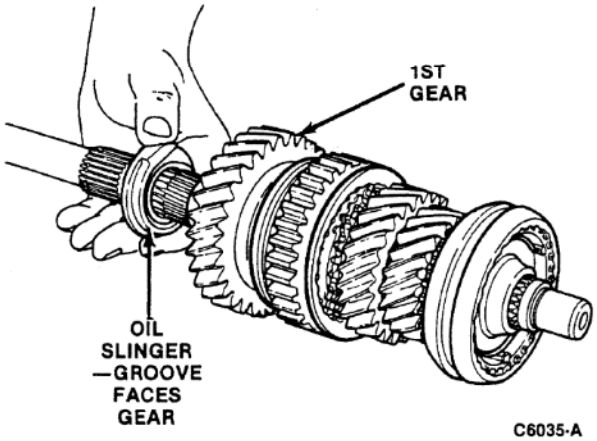


DISASSEMBLY AND ASSEMBLY

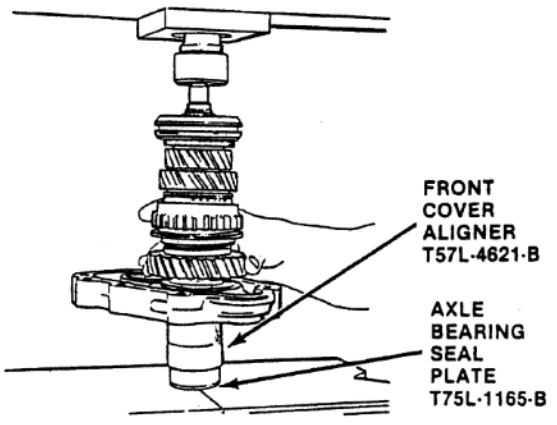
OUTPUT SHAFT

Assembly (Continued)

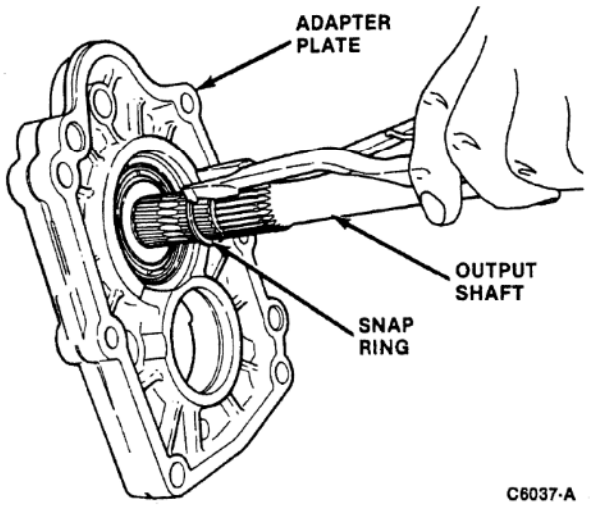
8. Install the oil slinger with the oil groove facing first gear.



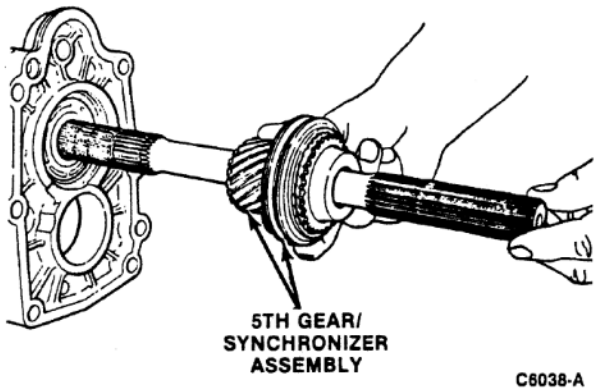
9. Install the rear bearing and adapter plate assembly using Front Cover Aligner T57L-4621-B with Axle Bearing Seal Plate T75L-1165-B.



10. Install a new selective fit rear bearing snap ring on the output shaft.



11. Install fifth gear and fifth-gear synchronizer.

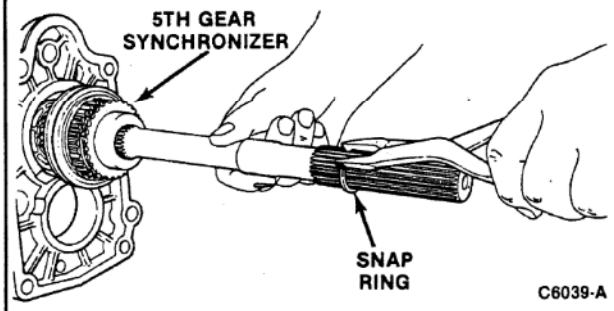


DISASSEMBLY AND ASSEMBLY

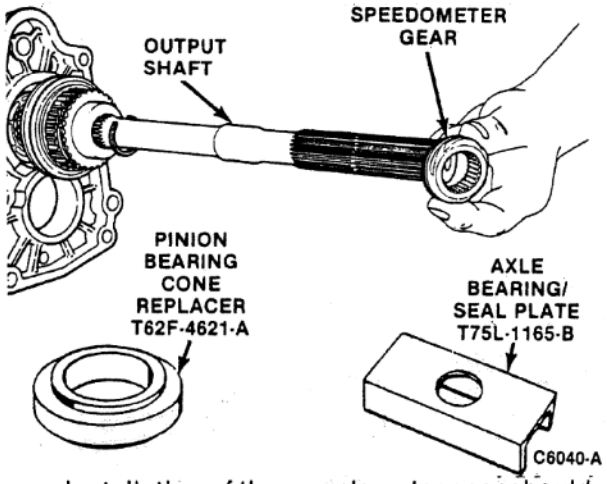
OUTPUT SHAFT

Assembly (Continued)

12. Install a new selective fit fifth-gear snap ring on the output shaft.



13. Install the speedometer gear, using Axle Bearing/Seal Plate T75L-1165-B and Pinion Bearing Cone Replacer T62F-4621-A, or equivalents. Press the gear onto the shaft until it aligns with the mark made during disassembly.



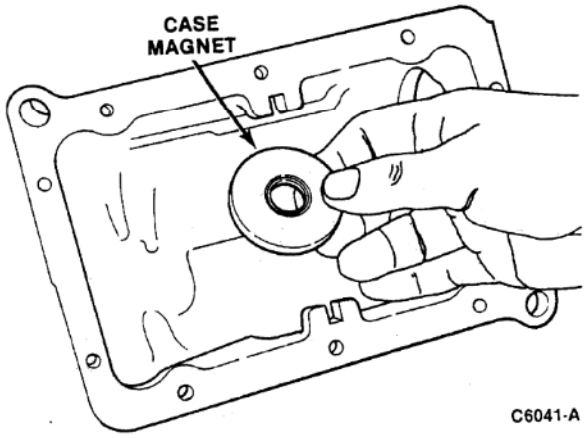
Installation of the speedometer gear should require a fair amount of force due to the interference fit between the gear and the output shaft. If the gear seems loose on the shaft, it must be replaced.

NOTE: If a new output shaft has been installed, press the speedometer gear onto the shaft until the distance from the front face of the gear to rear face of the fifth gear synchronizer hub measures 123 to 124 mm (4-27/32 to 4-7/8 in.).

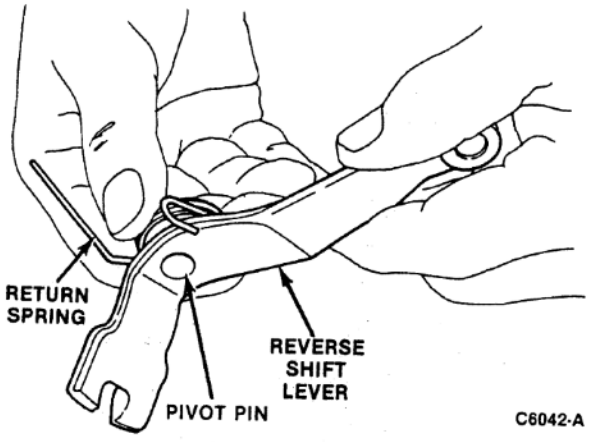
TRANSMISSION

Assembly

1. Install the ceramic magnet in the case.



2. Install the reverse shift lever return spring on the lever.

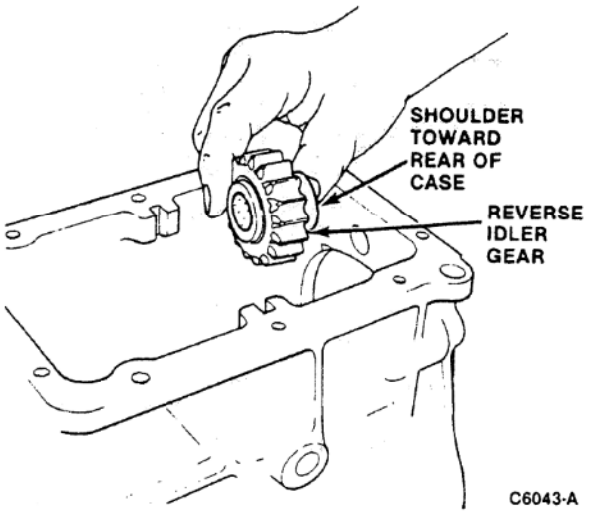


3. Position the return spring and reverse shift lever on the pivot pin.

NOTE: Be sure the spring is tensioned to return the lever to the released position and install the C-clip.

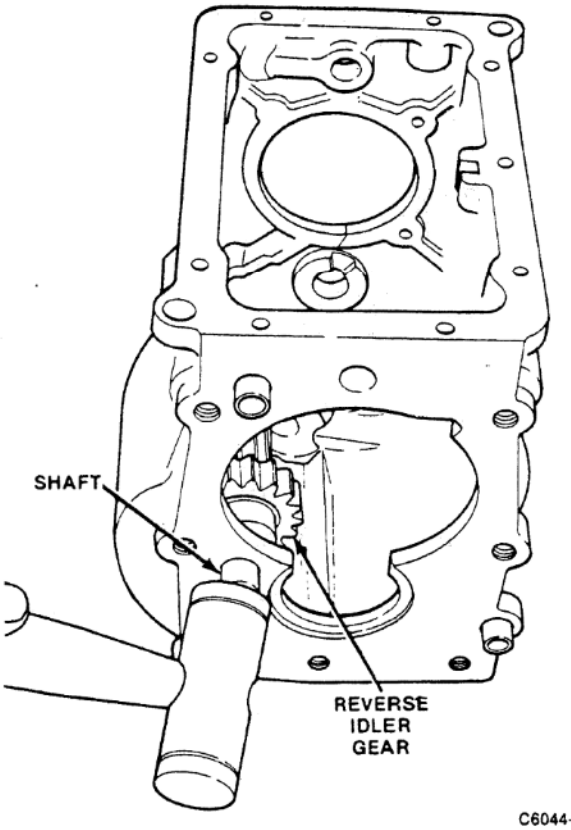
DISASSEMBLY AND ASSEMBLY (Continued)

4. Position the reverse idler gear in the case with the shoulder facing the rear of the case and with the gear engaged in the reverse shift lever.



5. Install the reverse idler gear shaft.

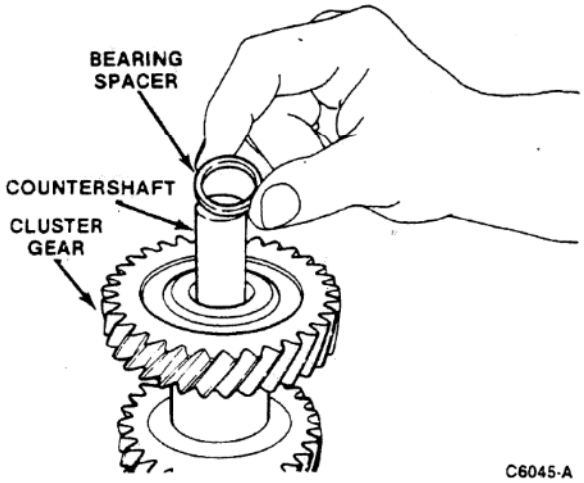
NOTE: Tap the shaft into the case with a plastic-tipped hammer.



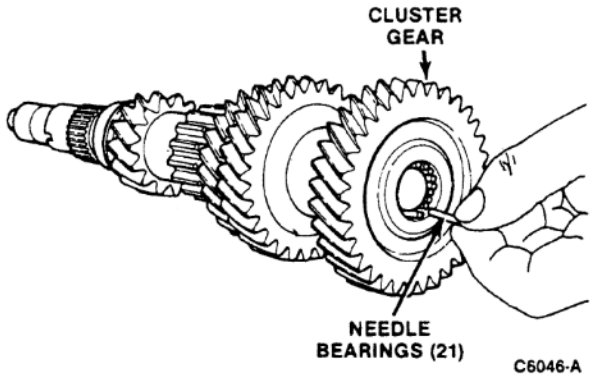
DISASSEMBLY AND ASSEMBLY (Continued)

NOTE: Steps 6, 7 and 8 are NOT required for 1987 and later model units. Go directly to Step 9 for such models.

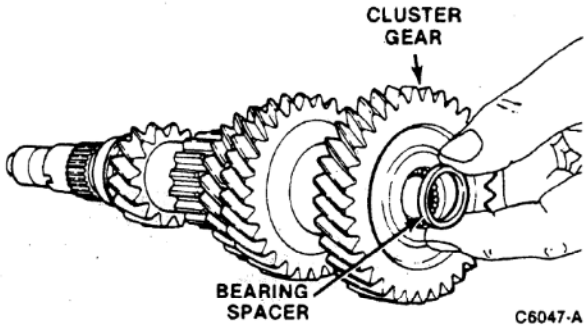
6. Position the countershaft in the cluster gear and install three bearing spacers in the front end of the cluster gear.



7. Install the needle bearings (21). Lubricate the bearings with petroleum jelly as they are installed in the cluster gear.



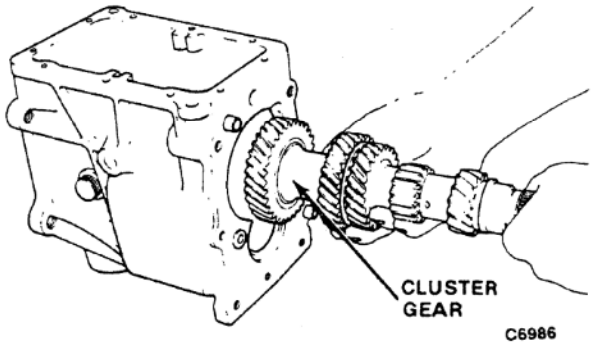
8. Install the remaining bearing spacer.



9. On 1987 and later models, press roller bearing flush into cluster gear bore using a press.

CAUTION: Ensure the bearing is pressed in by the outer race.

10. Install the cluster gear with the countershaft and lay it on the bottom of the case.

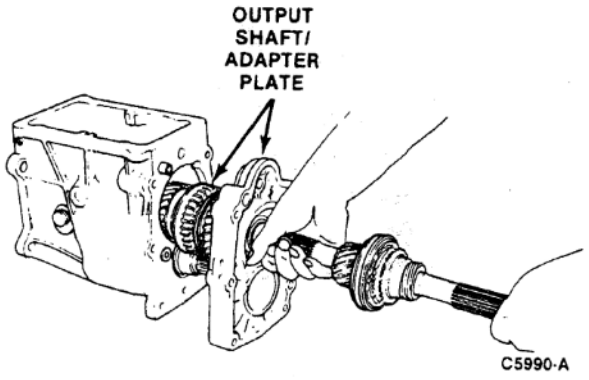


CAUTION: For models built prior to 1987 be sure the countershaft is pushed to the front until it supports the front needle bearings.

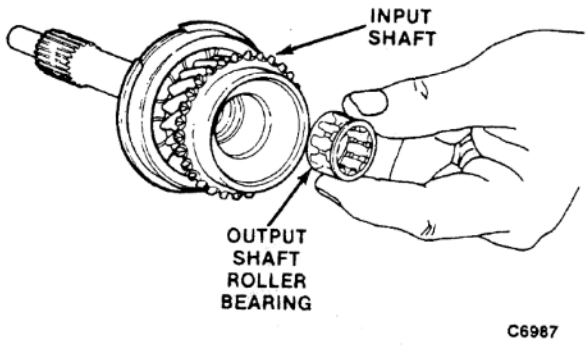
—As the front of the cluster gear enters the case, pull the countershaft rearward until the front of the shaft end is flush with the end of the cluster gear. Be sure the bearing spacer does not fall off the end of the countershaft while the cluster gear is being lowered into the case.

DISASSEMBLY AND ASSEMBLY (Continued)

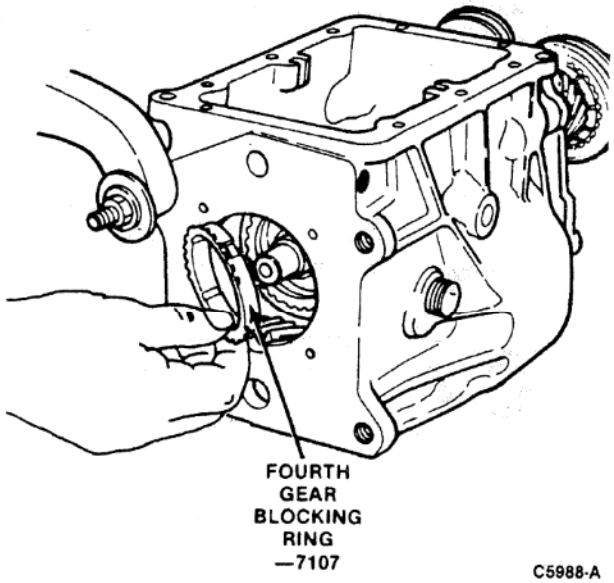
11. Position a new gasket on the adapter plate. Install the output shaft, adapter plate and gasket as an assembly.



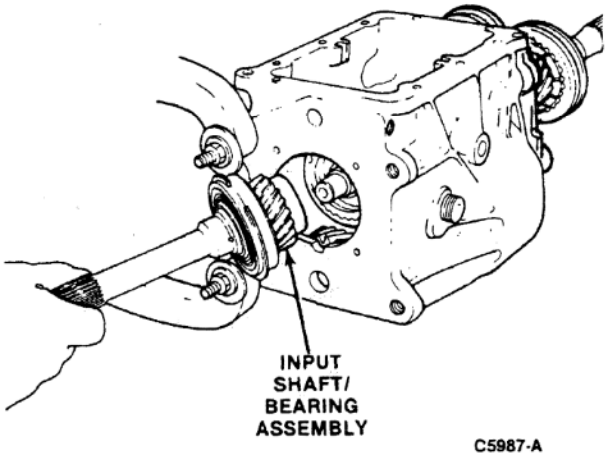
12. Coat the input shaft roller bearing with transmission oil and install in the end of the input shaft.



13. Install the fourth-gear blocking ring.

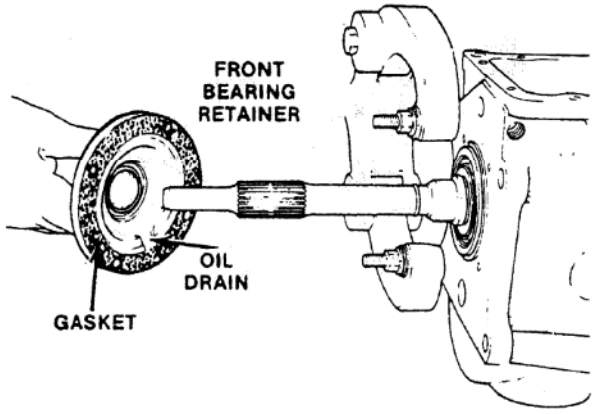


14. Install the input shaft.

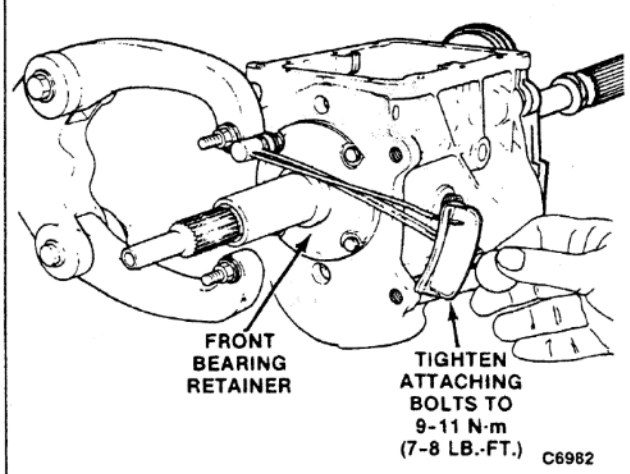


DISASSEMBLY AND ASSEMBLY (Continued)

15. Install a new gasket on the front bearing retainer. Position the bearing retainer on the case with the groove in the gasket and retainer, facing the bottom of the case to align with the oil drain hole.

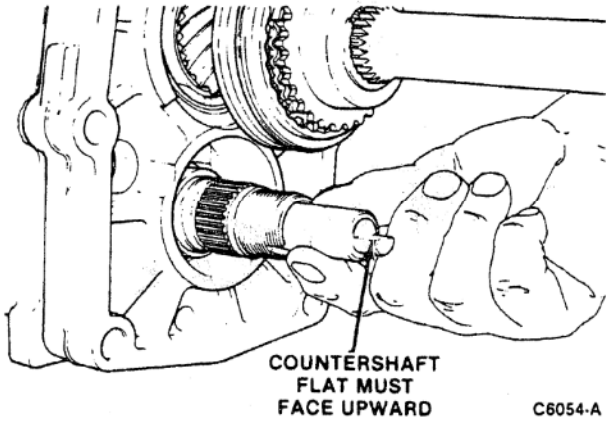


16. Install the front bearing retainer attaching bolts and tighten to 9 to 11 N·m (7 to 8 lb-ft).



NOTE: Step 17 is NOT required for 1987 and later model units. Go directly to Step 18 for such models.

17. Rotate the countershaft until the flat on the rear end of the shaft is facing up in the horizontal position.

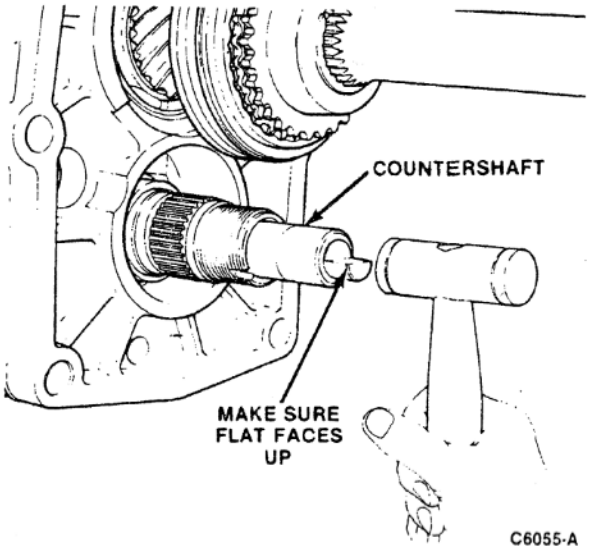


NOTE: Position of the flat is critical because it must fit into a matching flat in the extension housing. If the flat is not properly positioned, the extension housing will not be able to be correctly installed.

18. Raise the front of the cluster gear to align the countershaft with the countershaft bore in the case.

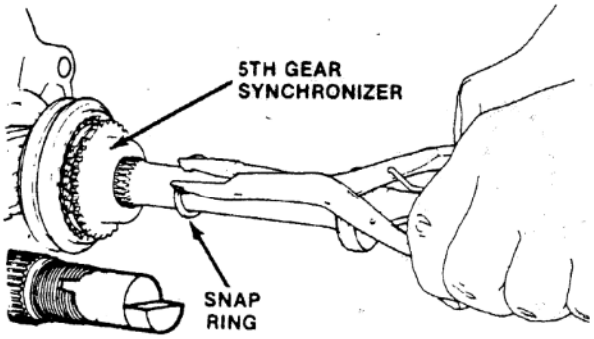
—While holding this alignment, tap the countershaft forward into the case bore.

—For 1987 and later units, install the countershaft support in the front of the transmission case.



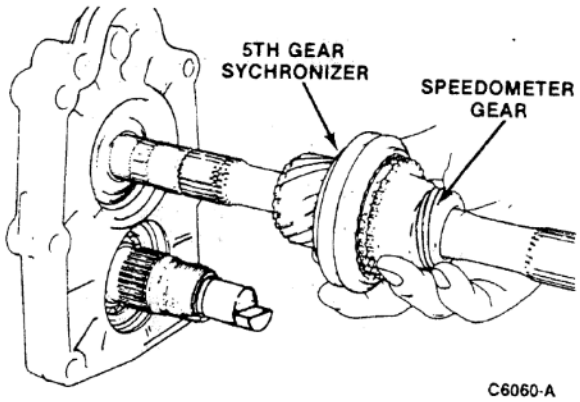
DISASSEMBLY AND ASSEMBLY (Continued)

19. Remove the fifth-gear synchronizer snap ring from the output shaft groove (if this snap ring was fully installed in Step 12 of the output shaft assembly).



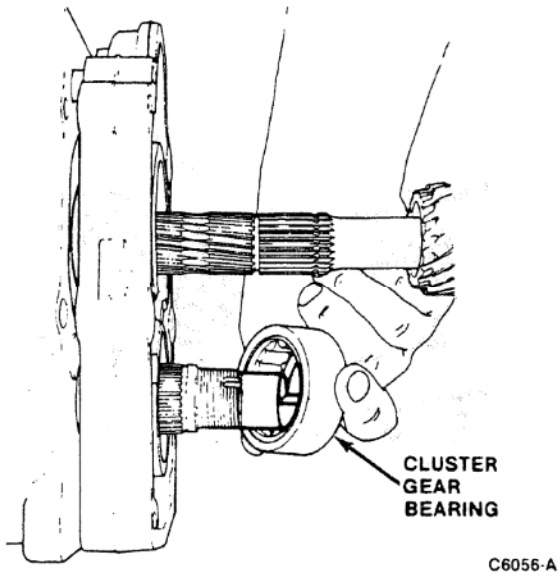
C6059-A

20. Slide the synchronizer and snap ring rearward against the speedometer gear, to allow clearance for installation of fifth gear.



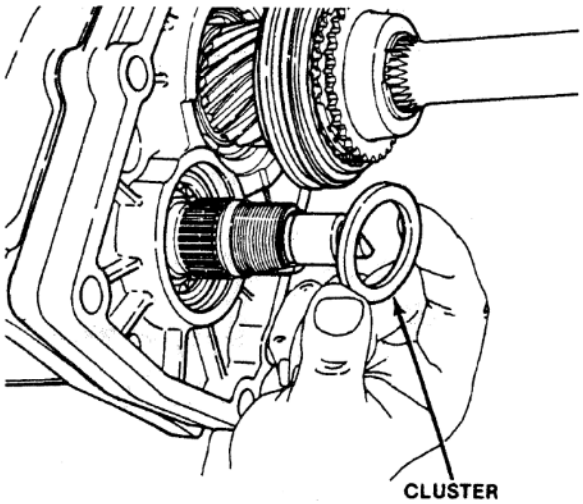
C6060-A

21. Install the cluster gear rear bearing.



C6056-A

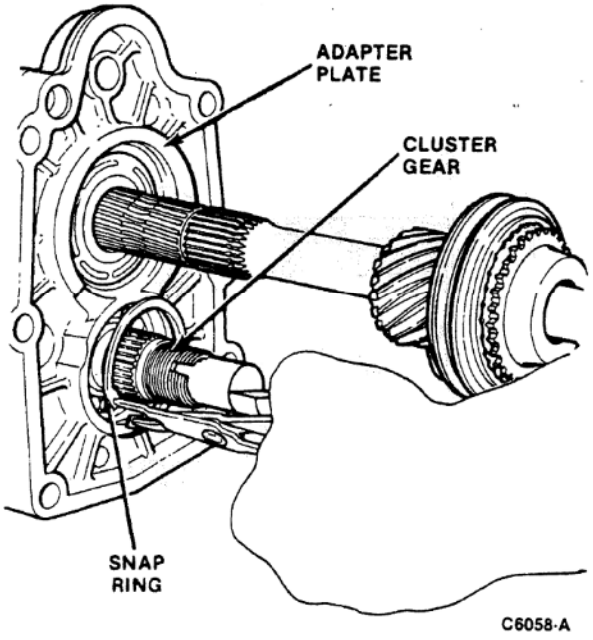
22. Install the cluster gear bearing spacer.



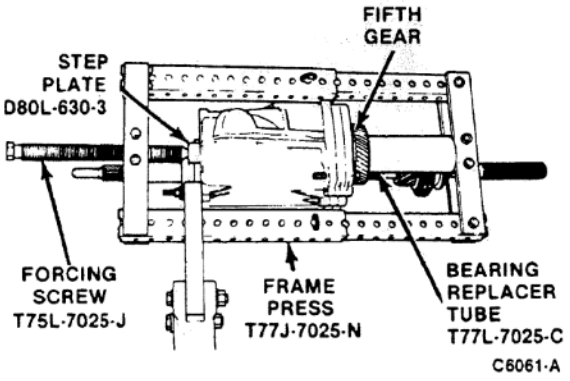
C6057-A

DISASSEMBLY AND ASSEMBLY (Continued)

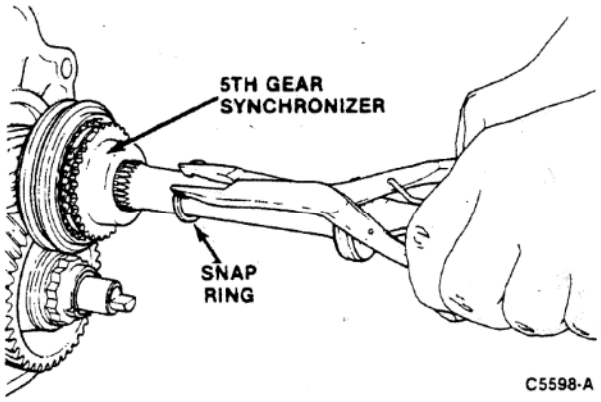
23. Install the cluster gear rear bearing snap ring.



24. Install fifth gear on the cluster gear using Forcing Screw T75L-7025-J, Step Plate D80L-630-3, Adjustable Frame Press T77J-7025-N and Bearing Replacer Tube T77L-7025-C, or equivalents.



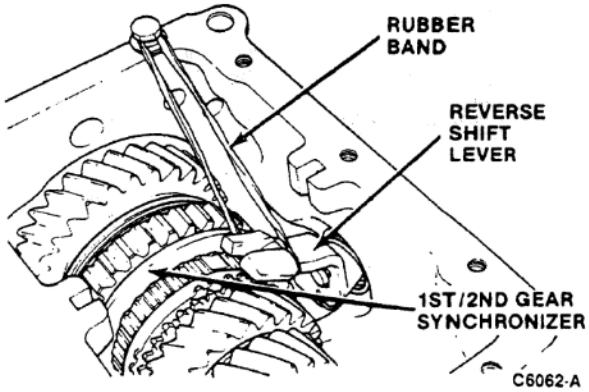
25. Position fifth gear and the fifth-gear synchronizer. Install the fifth-gear synchronizer snap ring.



26. If necessary, install a cover bolt in the transmission case.

    To prevent rotation of the mainshaft and cluster gear, shift the transmission into first and reverse gears.

    To hold the reverse idler gear in position, stretch a rubber band from the reverse lever to the cover bolt screwed into the transmission case.

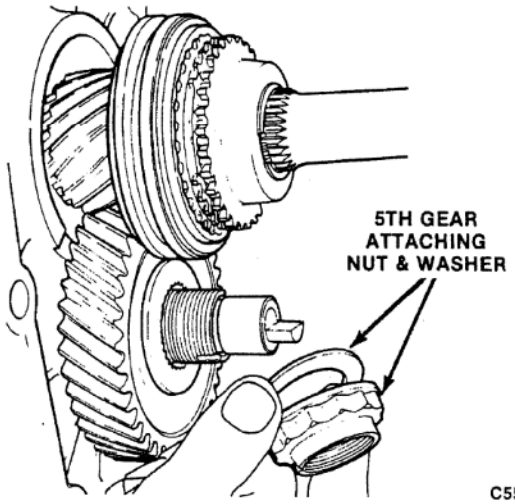


DISASSEMBLY AND ASSEMBLY

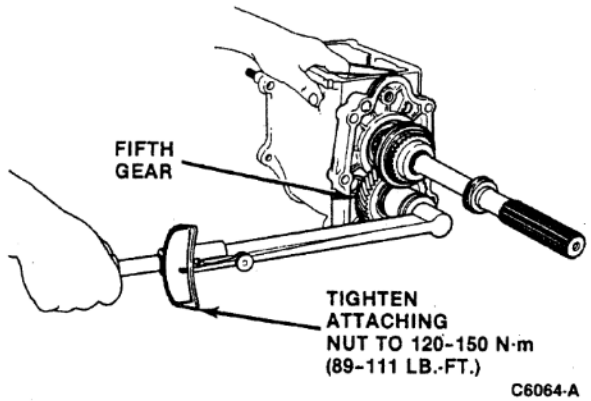
TRANSMISSION

Assembly (Continued)

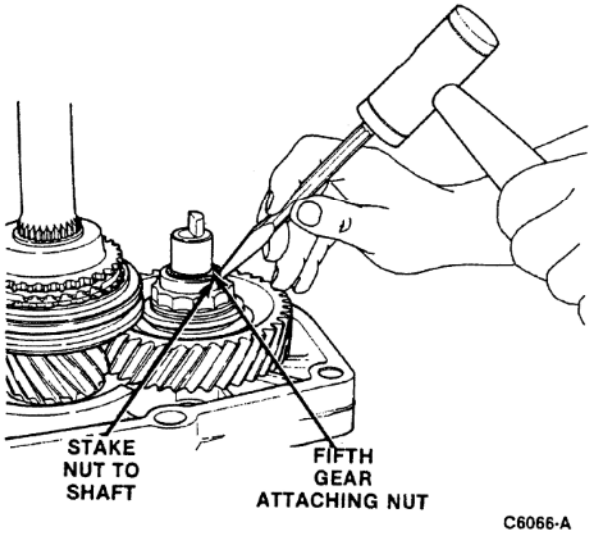
27. Install the fifth-gear attaching nut and washer.



28. Using a 36 mm or 1-7/16 inch, 12-point socket, tighten the fifth-gear attaching nut to 120 to 150 N·m (89 to 111 lb-ft).

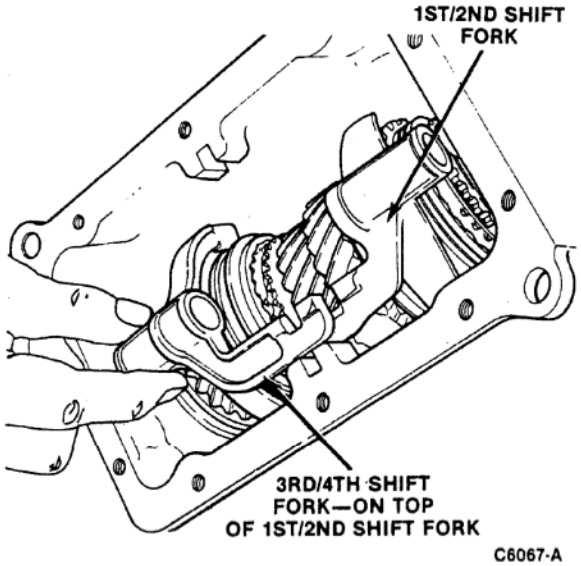


29. Stake the fifth-gear attaching nut, using a punch.



30. Remove the rubber band and cover bolt. Shift the transmission out of first and reverse gears.

31. Install the first/second and third/fourth shift forks. Be sure the third/fourth fork is on top of the first/second fork.



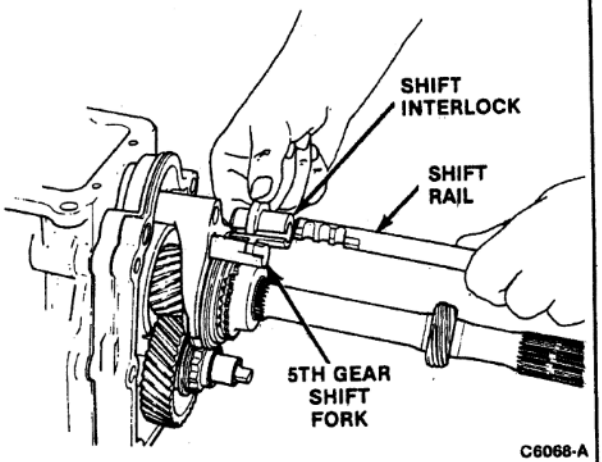
DISASSEMBLY AND ASSEMBLY

TRANSMISSION

Assembly (Continued)

32. Position the fifth gear shift fork and interlock on the fifth synchronizer.

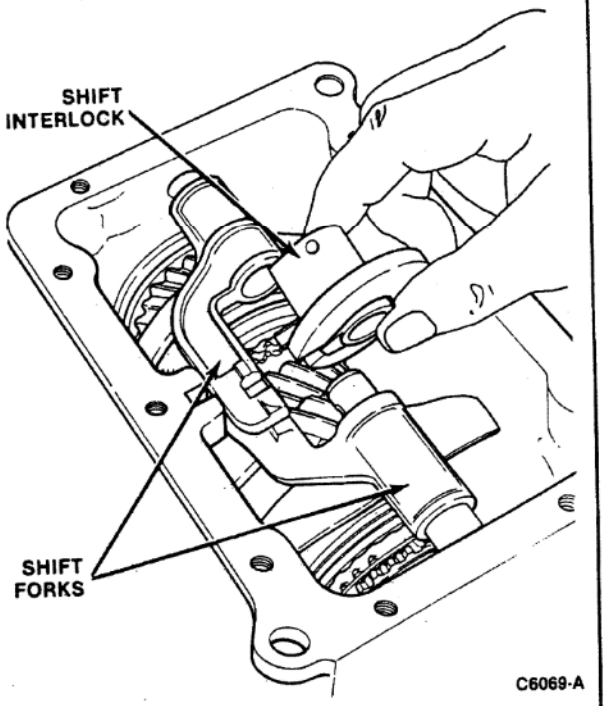
    —Slide the shift rail through the interlock and shift fork until it enters the case.



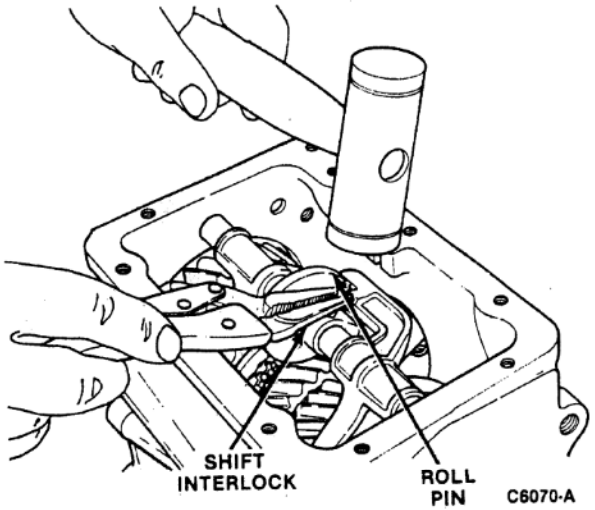
33. Position the first/second shift fork, the second/third shift interlock and cam, and the third/fourth shift fork. Then slide the shift rail through the shift forks and shift interlock until the shaft enters the bore at the front of the case.

    —Be sure the fifth-gear interlock is correctly aligned to allow the shift rail to slide through the shifter fork.

    —Be sure the synchronizers are in neutral and that the shift forks engage the synchronizer sleeves.



34. Align the shift rail with the shift interlock and install the roll pin.

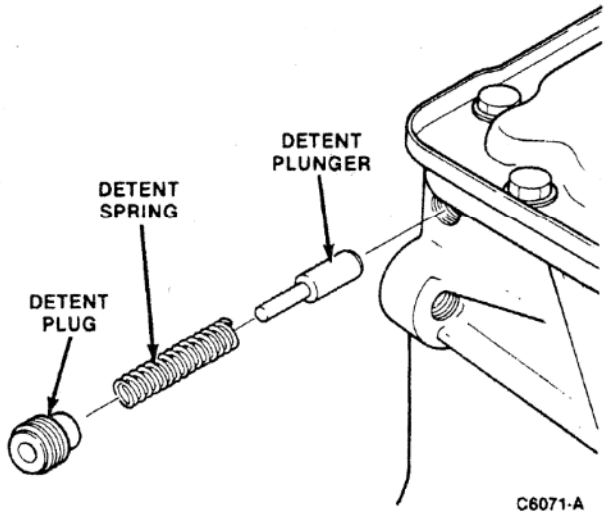


NOTE: To facilitate installation of the pin, use the center detent on the shift rail as the point of alignment.

DISASSEMBLY AND ASSEMBLY (Continued)

35. Apply Pipe Sealant D8AZ-19558-A, or equivalent, to the detent plug threads. Install the shift detent plunger, spring and plug.

    Tighten the plug to 17 to 19 N·m (13 to 14 lb-ft).

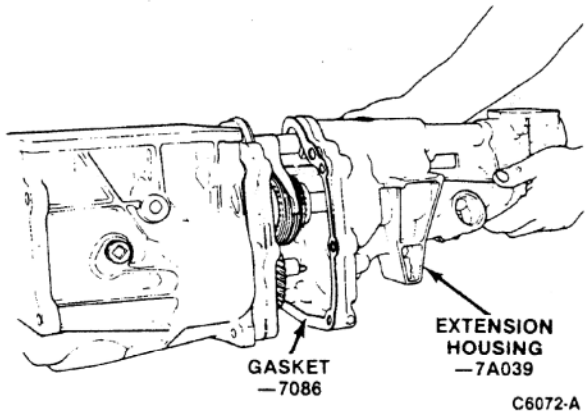


36. Shift the transmission into fourth gear.
37. Position a new extension housing gasket.

38. Position a new gasket and install the extension housing.

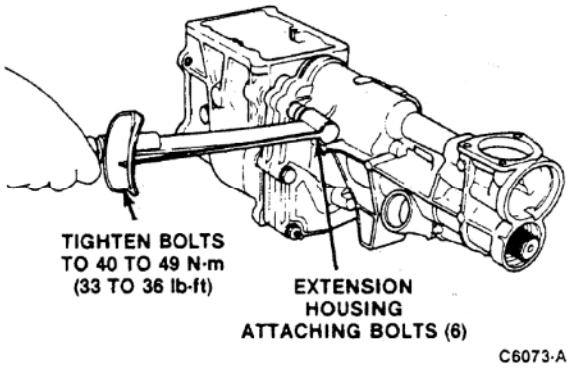
    —Make sure that the spring on the shift rail engages properly with the pin in the extension housing.

    —On units built prior to 1987 make sure that the flat on the countershaft and the matching flat in the extension housing are aligned.



39. Install the extension housing attaching bolts.

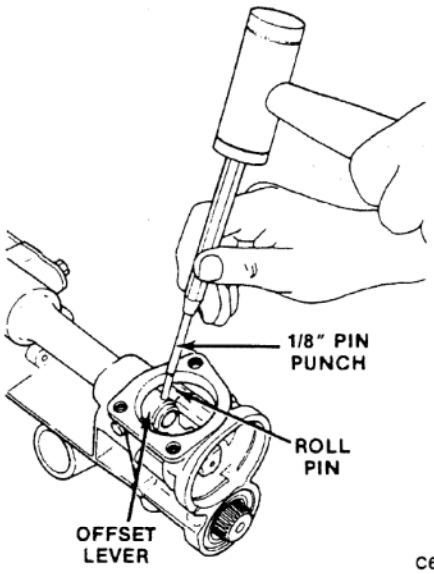
    Tighten the attaching bolts to 40 to 49 N·m (33 to 36 lb-ft).



    —Apply Pipe Sealant D8AZ-195540A, or equivalent, on the threads of the three bolts entering the transmission case.

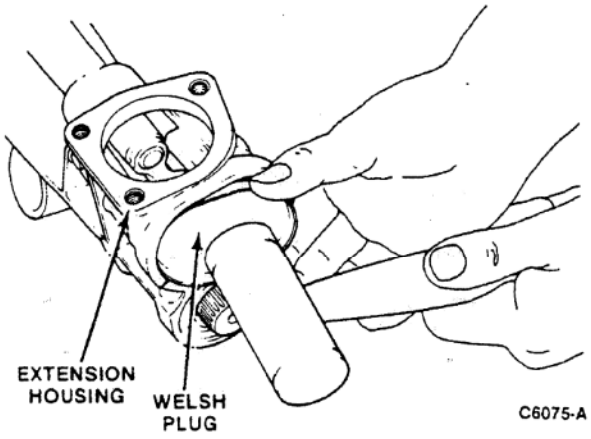
40. Shift the transmission into reverse gear.

41. Position the offset lever on the shifter shaft and install the roll pin, using a 1/8-inch pin punch.

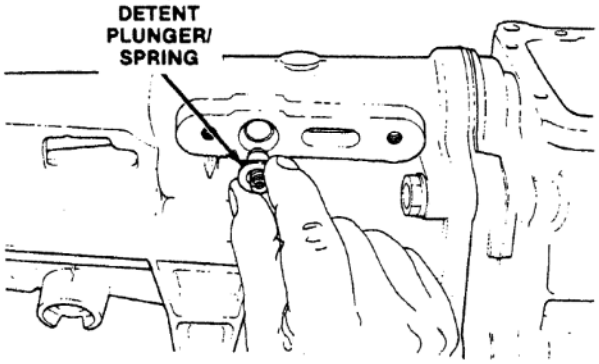


DISASSEMBLY AND ASSEMBLY (Continued)

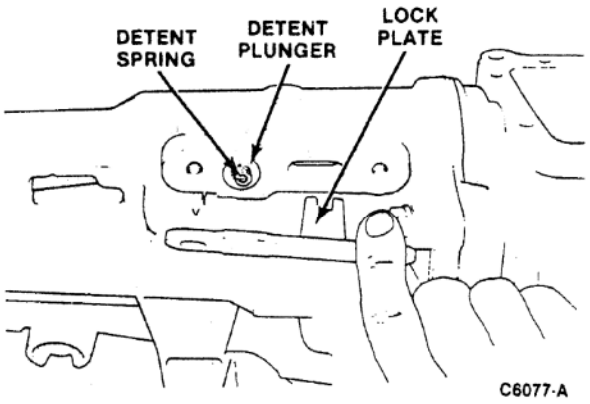
42. Install the welsh plug in the extension housing.



43. Install the fifth-gear detent plunger and spring.

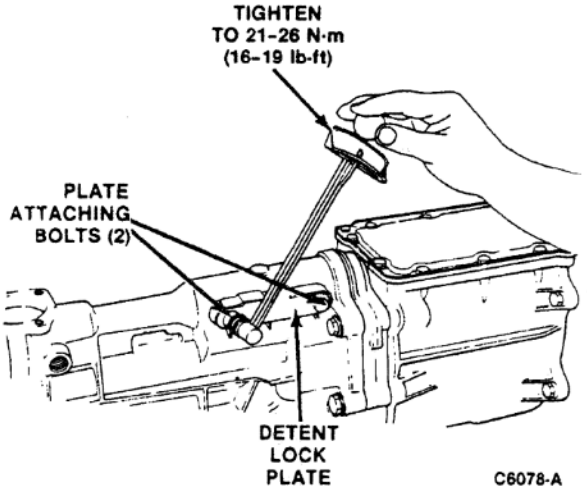


44. Install the fifth-gear detent lock plate. Before installing the detent lock plate, apply a nonhardening type sealant on the plate to extension housing mating surface.



45. Tighten the lock plate attaching bolts to 21 to 26 N·m (16 to 19 lb-ft).

    Coat the detent lock plate attaching bolts with Sealant E0AZ-19954-A, or equivalent, and install the bolts.

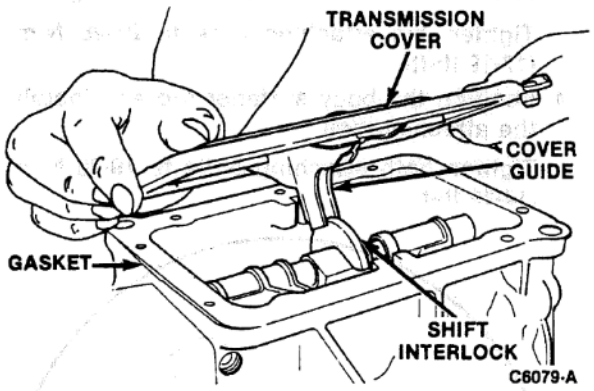


DISASSEMBLY AND ASSEMBLY

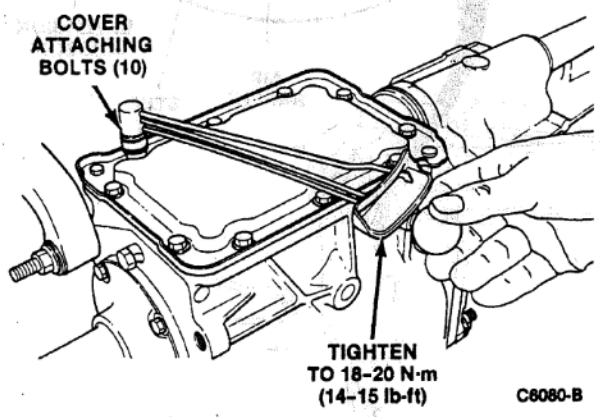
TRANSMISSION

Assembly (Continued)

46. Position a new gasket and install the transmission cover. Be sure the cover guide engages the shift interlock.



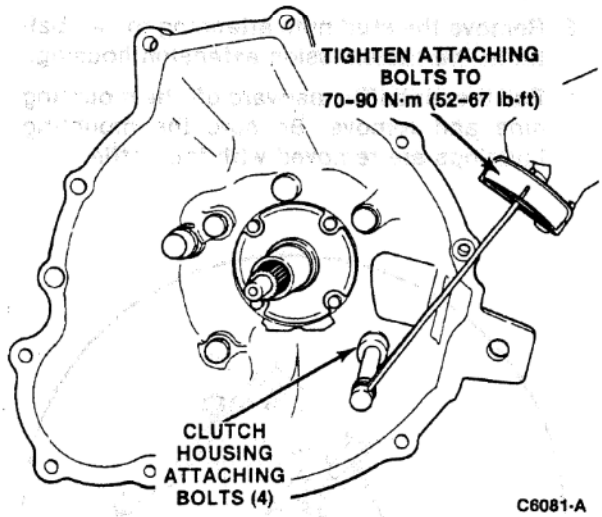
47. Tighten the cover attaching bolts 18 to 20 N·m (14 to 15 lb-ft).



48. Wrap the back-up light switch threads and neutral safety switch threads with teflon tape and install in the extension housing.

    Tighten the switches to 10 to 14 N·m (7 to 10 lb-ft).

49. Install the flywheel housing.
50. Tighten the flywheel housing attaching bolts to 70 to 90 N·m (52 to 67 lb-ft).



51. Install the clutch release lever and bearing.
52. Fill the transmission to the correct level with lubricant E5RY-19C547-A (Ford Specification ESD-M-2C175A.
53. Install the speedometer driven gear in the extension housing.

FLUID LEVEL CHECK

NOTE: The transmission lubricant is a semisynthetic oil. When adding oil to the transmission, use only E5RY-19C-547A (Ford Specification ESD-M-2C175A).

The transmission is filled to the proper level when the lubricant is even with the bottom of the filler plug hole.

NOTE: If the transmission is equipped with an air baffle, it must be removed before the lubricant level can be checked. If necessary, refer to the removal and installation procedure on the next page.

FLUID LEVEL CHECK

AIR BAFFLE

Removal

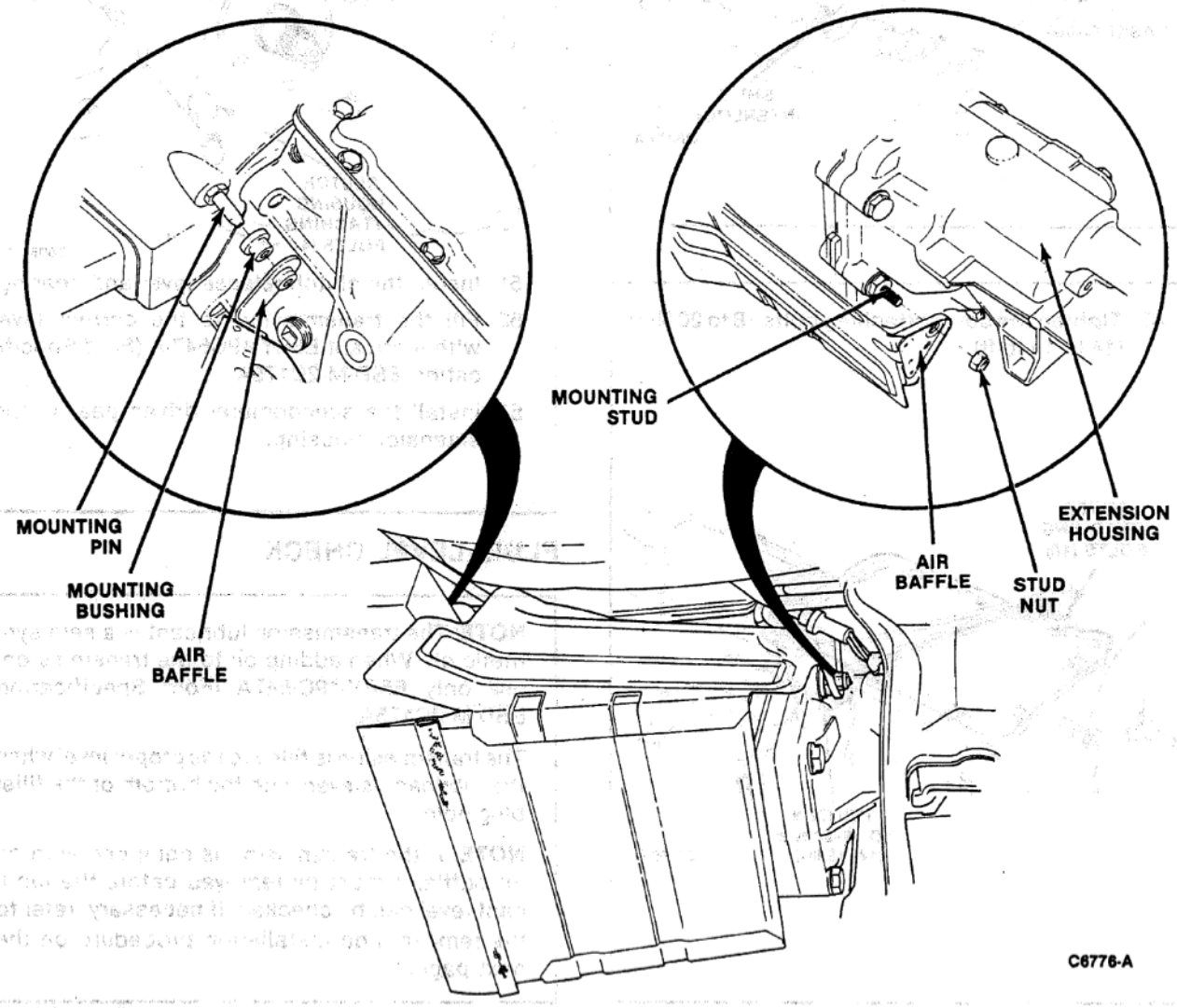
1. Remove the bolt attaching the body stiffener rod to the right-hand frame rail.
2. Loosen the bolt attaching the body stiffener rod to the left frame rail and swing the rod downward.
3. Remove the stud nuts attaching the air baffle to the transmission extension housing.
4. Pull the air baffle rearward off the mounting pins and remove. Be sure the mounting bushings are removed with the baffle.

Installation

1. Be sure the mounting bushings are in position on the baffle.
2. Position the air baffle around the transmission and slide forward over the front mounting pins and the rear mounting studs.
3. Install the stud nuts attaching the air baffle to the transmission extension housing.

   Tighten the attaching nuts to 21-26 N·m (17-19 lb-ft).
4. Position the body stiffener rod and install the attaching bolt.

   Tighten both attaching bolts to 19-26 N·m (14-19 lb-ft).



GROUP 16 SPECIFICATIONS

TRANSMISSION MODEL: 5-speed manual transmission (5th speed overdrive)

GEAR RATIOS: 1st—3.36:1
2nd—1.81:1
3rd—1.26:1
4th—1.00:1
5th—0.83:1
Reverse—3.36:1

LUBRICANT: E5RY-19C-547A

NOTE: The transmission lubricant is a semisynthetic oil. When adding oil to the transmission, use only E5RY-19C-547A (Ford Specification ESD-M-2C175A).

CLUTCH TYPE: Bellville spring with self-adjusting release cable

TORQUE SPECIFICATIONS

Item	N·m	lb-ft
Flywheel housing to engine	38-51	28-38
Engine rear cover to flywheel housing	38-51	28-38
Engine mount stud nut	68-95	50-70
Rear mount to body	34-48	25-35
Rear mount to transmission	68-95	50-70
Stabilizer brackets to body	45-56	33-41
Exhaust inlet pipe to turbocharger	34-48	25-35
Converter outlet to muffler inlet	28-40	21-30
Starter motor to flywheel housing	20-27	15-20
Front bearing retainer to case	9-11	7-8
Fifth-gear attaching nut	120-150	89-111
Shift detent plug	17-19	13-14
Extension housing to case	40-49	33-36
Interlock plate to case	21-26	16-19
Cover to case	18-20	14-15
Flywheel housing to case	70-90	52-67
Pressure plate to flywheel	20-25	15-19
Flywheel to crankshaft	73-87	56-64
Air baffle stud nut	21-26	17-19

AUTOMATIC TRANSMISSION

GROUP 17 (7000)

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GROUP 17

SPECIFICATIONS 1

SECTION 17-01
AUTOMATIC TRANSMISSION DIAGNOSIS

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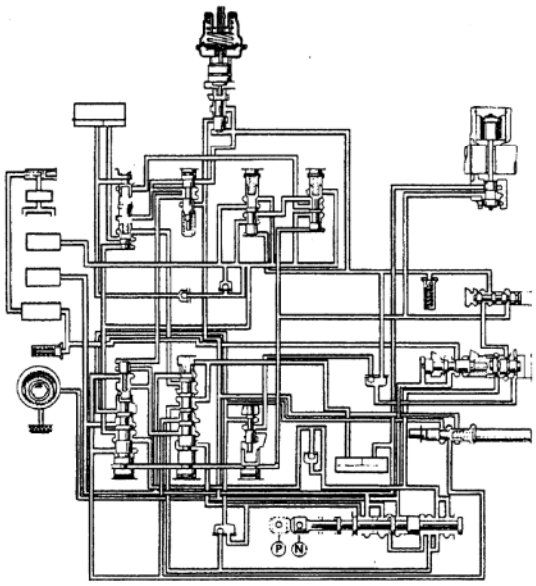
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D5801-A

GENERAL INFORMATION

Automatic transmission malfunctions are generally the result of poor engine performance, incorrect fluid level, incorrect linkage adjustment, band, or hydraulic control pressure adjustments, hydraulic system malfunctions, or mechanical component malfunctions.

In all automatic transmission repair, the logical and proper procedure is diagnosis before disassembly. A systematic diagnosis procedure is important in avoiding repair delays caused by incorrect or unnecessary repairs. The diagnosis and test procedures outlined in this section should be performed in the following sequence to realize maximum effect: (1) preliminary diagnosis, (2) road test, (3) hydraulic pressure test, (4) air pressure test, (5) stall test, (6) analyze test results and consult diagnosis guides and charts for cause of malfunction.

THE DIAGNOSTIC SEQUENCE

1—PRELIMINARY DIAGNOSIS

2—ROAD TEST

3—HYDRAULIC PRESSURE CHECK

4—AIR PRESSURE CHECK

5—STALL TEST

6—ANALYZE

D5808-A

DIAGNOSIS

TROUBLESHOOTING CHART
AUTOMATIC TRANSMISSION

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Slow initial engagement	1. Improper fluid level	1. Perform fluid level check. If necessary, refer to the procedure in this section.
	2. Damaged or improperly adjusted linkage	2. Service or adjust linkage. If necessary, refer to Section 17-02.
	3. Contaminated fluid	3. Perform fluid condition check. If necessary, refer to the procedure in this section.
	4. Improper clutch and band application, or low main control pressure	4. Perform control pressure test. If necessary, refer to the procedure in this section.
Rough initial engagement in either forward or reverse	1. Improper fluid level	1. Perform fluid level check. If necessary, refer to the procedure in this section.
	2. High engine idle	2. Adjust idle to specifications. If necessary, refer to Section 21-01.
	3. Looseness in the driveshaft, U-joints or engine mounts	3. Service as required.
	4. Improper clutch or band application, or oil control pressure	4. Perform control pressure test. If necessary, refer to the procedure in this section.
	5. Valve body dirty/sticking valves	5. Clean, service or replace valve body. If necessary, refer to Section 17-03.
Harsh engagements—(warm engine)	1. Improper fluid level	1. Perform fluid level check. If necessary, refer to the procedure in this section.
	2. Vacuum modulator not operating properly	2. Check modulator operation. If necessary, refer to the procedures in this section.

D5803-A1

DIAGNOSIS

TROUBLESHOOTING CHART
AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Harsh engagement (Continued)	3. Engine curb idle too high	3. Check engine curb idle. If necessary, refer to Section 21-01.
	4. Valve body bolts—loose/too tight	4. Tighten to specification. If necessary, refer to Section 17-03.
	5. Valve body dirty/sticking valves	5. Clean, service or replace valve body. If necessary, refer to Section 17-03.
No/delayed forward engagement (reverse OK)	1. Improper fluid level	1. Perform fluid level check. If necessary, refer to the procedure in this section.
	2. Manual linkage—misadjusted/damaged	2. Check and adjust or service as required. If necessary, refer to Section 17-02.
	3. Low main control pressure (leakage)	3. Perform pressure test. If necessary, refer to the procedure in this section.
	4. Forward clutch assembly burnt/damaged	4. Perform air pressure test. If necessary, refer to the procedure in this section.
	5. Forward clutch cylinder check ball leaking/leaking piston seal rings	5. Perform air pressure test. If necessary, refer to the procedure in this section.
	6. Valve body bolts—loose/too tight	6. Tighten to specification. If necessary, refer to Section 17-03.
	7. Valve body dirty/sticking valves	7. Clean, service or replace valve body. If necessary, refer to Section 17-03.
	8. Transmission filter plugged	8. Replace filter. If necessary, refer to Section 17-03.
	9. Pump damaged/leaking causing low control pressure	9. Perform control pressure test. If necessary, refer to the procedure in this section.

D5803-A2

DIAGNOSIS

TROUBLESHOOTING CHART
AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
No/delayed reverse engagement (forward OK)	1. Improper fluid level	1. Perform fluid level check. If necessary, refer to the procedure in this section.
	2. Manual linkage misadjusted/damaged	2. Check and adjust or service as required. If necessary, refer to Section 17-02.
	3. Low main control pressure in reverse	3. Perform pressure test. If necessary, refer to the procedure in this section.
	4. Reverse/high clutch assembly burnt/worn	4. Air pressure test. If necessary, refer to the procedure in this section.
	5. Reverse/high clutch piston check ball leaking/leaking piston seal rings	5. Air pressure test. If necessary, refer to the procedure in this section.
	6. Valve body bolts loose/too tight	6. Tighten to specification. If necessary, refer to Section 17-03.
	7. Valve body dirty/sticking valves	7. Clean, service or replace valve body. If necessary, refer to Section 17-03.
	8. Transmission filter plugged	8. Replace filter. If necessary, refer to Section 17-03.
	9. Pump damaged/leaking causing low control pressure	9. Visually inspect pump gears. Replace if necessary.
	10. Intermediate servo piston seal cut/leaking	10. Check and replace piston seal. If necessary, refer to Section 17-03.

D5803-A3

DIAGNOSIS

TROUBLESHOOTING CHART
AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
No/delayed reverse engagement and/or no engine braking in manual low	1. Improper fluid level	1. Perform fluid level check. If necessary, refer to the procedure in this section.
	2. Low reverse band burnt/worn	2. Perform air pressure test. If necessary, refer to the procedure in this section.
	3. Low reverse servo piston seal leaking	3. Air pressure test. If necessary, refer to the procedure in this section.
	4. Low/reverse band out of adjustment	4. Check apply pin length. If necessary, refer to Section 17-03.
	5. Polished, glazed band or drum	5. Service or replace as required. If necessary, refer to Section 17-03.
	6. Endplay clearance too tight	6. Check transmission endplay clearance. If necessary, refer to Section 17-03.
No engine braking in manual second gear	1. Intermediate band out of adjustment	1. Adjust intermediate band. If necessary, refer to Section 17-03.
	2. Improper band or clutch application, or oil pressure control system	2. Perform control pressure test. If necessary, refer to the procedure in this section.
	3. Intermediate servo leaking	3. Perform air pressure test of intermediate servo for leakage. If necessary, refer to the procedure in this section. Service as required. If necessary, refer to Section 17-03.
	4. Polished or glazed intermediate band or drum	4. Service or replace as required. If necessary, refer to Section 17-03.

D5803-A4

DIAGNOSIS

TROUBLESHOOTING CHART
AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Forward engagement slips/ shudders/chatters	1. Improper fluid level	1. Perform fluid level check. If necessary, refer to the procedure in this section.
	2. Manual linkage misadjusted/damaged	2. Check and adjust or service as required. If necessary, refer to Section 17-02.
	3. Low main control pressure	3. Control pressure test. If necessary, refer to the procedure in this section.
	4. Valve body bolts—loose/ too tight	4. Tighten to specification. If necessary, refer to Section 17-03.
	5. Valve body dirty/sticking valves	5. Determine source of contamination. Service as required. If necessary, refer to Section 17-03.
	6. Forward clutch piston ball check not seating/leaking	6. Replace forward clutch cylinder. Service transmission as required. If necessary, refer to Section 17-03.
	7. Forward clutch piston seal cut/worn	7. Replace seal and service clutch as required. If necessary, refer to Section 17-03.
	8. One-way clutch damaged	8. Service as required. If necessary, refer to Section 17-03.
Reverse shudders/chatters/slips	1. Improper fluid level	1. Perform fluid level check. If necessary, refer to the procedure in this section.
	2. Low main control pressure in reverse	2. Perform control pressure test. If necessary, refer to the procedure in this section.
	3. Low/reverse servo leaking	3. Air pressure test; visually inspect seal rings and piston bore. If necessary, refer to the procedure in this section.

D5803-A5

DIAGNOSIS

TROUBLESHOOTING CHART
AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Reverse shudders/chatters/slips (Continued)	4. Reverse clutch drum bushing damaged	4. Determine cause of condition. Service as required. If necessary, refer to Section 17-03.
	5. Reverse/high clutch piston seal cut/worn	5. Determine cause of condition. Service as required.
	6. Low/reverse band out of adjustment or damaged	6. Check apply pin length. If necessary, refer to Section 17-03.
	7. Looseness in the driveshaft, U-joints or engine mounts	7. Service as required.
No drive, slips or chatters in first gear in D. All other gears normal	1. Damaged or worn (planetary) one-way clutch	1. Service or replace one-way clutch. If necessary, refer to Section 17-03.
No drive, slips or chatters in second gear	1. Intermediate band out of adjustment	1. Adjust intermediate band. If necessary, refer to Section 17-03.
	2. Improper band or clutch application	2. Perform air pressure test. If necessary, refer to the procedure in this section.
	3. Low main control pressure	3. Perform control pressure test. If necessary, refer to the procedure in this section.
	4. Intermediate band adjustment	4. Check band adjustment. If necessary, refer to the procedure in this section.
	5. Valve body dirty/sticking valves	5. Clean, service or replace valve body. If necessary, refer to Section 17-03.
	6. Polished, glazed intermediate band or drum	6. Replace or service as required. If necessary, refer to Section 17-03.

D5803-A6

DIAGNOSIS

TROUBLESHOOTING CHART
AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Initial drive in 2nd or 3rd	1. Improper band and/or clutch application, or oil pressure control system	1. Perform control pressure test. If necessary, refer to the procedure in this section.
	2. Damaged or worn governor. Sticking governor	2. Perform governor check. Replace or service governor, clean screen. If necessary, refer to the procedure in this section.
	3. Valve body loose	3. Tighten to specification. If necessary, refer to Section 17-03.
	4. Valve body dirty/sticking valves	4. Clean, service or replace valve body. If necessary, refer to Section 17-03.
	5. Cross leaks between valve body and case mating surface	5. Service or replace valve body and/or case as required. If necessary, refer to Section 17-03.
Shift points incorrect	1. Improper fluid level	1. Perform fluid level check. If necessary, refer to the procedure in this section.
	2. Vacuum modulator line damaged, clogged or leaks	2. Check vacuum modulator. If necessary, refer to the procedure in this section.
	3. Improper operation of EGR system	3. Service or replace as required.
	4. Vacuum modulator not operating properly	4. Check modulator operation. If necessary, refer to the procedures in this section.
	5. Improper speedometer gear installed	5. Replace gear. If necessary, refer to Section 17-03.
	6. Improper clutch or band application, or oil pressure control system	6. Road-test and perform control pressure test. If necessary, refer to the procedure in this section.
	7. Damaged or worn governor	7. Service or replace governor—clean screen. If necessary, refer to Section 17-03.

D5803-A7

DIAGNOSIS

TROUBLESHOOTING CHART
AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Shift points incorrect (Continued)	8. Vacuum diaphragm bent, sticking, or leaks	8. Check vacuum modulator operation. If necessary, refer to the procedure in this section.
	9. Valve body dirty/sticking valves	9. Clean, service or replace valve body. If necessary, refer to Section 17-03.
All upshifts harsh/delayed or no upshifts	1. Improper fluid level	1. Perform fluid level check. If necessary, refer to the procedure in this section.
	2. Manual linkage—misadjusted/damaged	2. Check and adjust or service as required. If necessary, refer to Section 17-02.
	3. Governor sticking	3. Perform governor test. Service as required. If necessary, refer to the procedure in this section.
	4. Main control pressure too high	4. Control pressure test. Service as required. If necessary, refer to the procedure in this section.
	5. Valve body bolts—loose/too tight	5. Tighten to specification. If necessary, refer to Section 17-03.
	6. Valve body dirty/sticking valves	6. Determine source of contamination. Service as required. If necessary, refer to Section 17-03.
	7. Vacuum leak to modulator	7. Check vacuum lines to modulator. Service as necessary. Perform vacuum supply and diaphragm tests. If necessary, refer to the procedure in this section.
	8. Vacuum modulator diaphragm bent/sticking/leaks	8. Check modulator. Service as necessary. If necessary, refer to the procedure in this section.

D5803-A8

DIAGNOSIS

TROUBLESHOOTING CHART
AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Mushy/early upshifts; pile up/ upshifts	1. Improper fluid level	1. Perform fluid level check. If necessary, refer to the procedure in this section.
	2. Low main control pressure	2. Perform control pressure test. If necessary, refer to the procedure in this section.
	3. Valve body bolts loose/too tight	3. Tighten to specification. If necessary, refer to Section 17-03.
	4. Valve body dirty/sticking valves	4. Determine source of contamination. Service as required. If necessary, refer to Section 17-03.
	5. Governor valve sticking	5. Perform governor test. Repair as required. If necessary, refer to the procedure in this section.
No 1-2 upshift	1. Improper fluid level	1. Perform fluid level check. If necessary, refer to the procedure in this section.
	2. Manual linkage—misadjusted/damaged	2. Check and adjust or service as required. If necessary, refer to Section 17-02.
	3. Governor valve sticking	3. Perform governor test. Service as required. If necessary, refer to the procedure in this section.
	4. Intermediate band out of adjustment	4. Adjust intermediate band. If necessary, refer to Section 17-03.
	5. Vacuum leak to modulator	5. Check vacuum lines to modulator. Service as required. If necessary, refer to the procedure in this section.
	6. Vacuum modulator diaphragm bent/sticking/ leaks	6. Check modulator. Service as necessary. If necessary, refer to the procedure in this section.

D5803-A9

DIAGNOSIS

TROUBLESHOOTING CHART
AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
No 1-2 upshift (Cont'd)	7. Valve body bolts—loose/too tight	7. Tighten to specification. If necessary, refer to Section 17-03.
	8. Valve body dirty/sticking valves	8. Determine source of contamination. Service as required. If necessary, refer to Section 17-03.
	9. Intermediate clutch band and/or servo assembly burnt	9. Perform air pressure test. If necessary, refer to the procedure in this section.
Rough/harsh/delayed 1-2 upshift	1. Improper fluid level	1. Perform fluid level check. If necessary, refer to the procedure in this section.
	2. Poor engine performance	2. Tune engine. If necessary, refer to Section 21-01.
	3. Intermediate band out of adjustment	3. Adjust intermediate band. If necessary, refer to Section 17-02.
	4. Main control pressure too high	4. Control pressure test. Note results. If necessary, refer to the procedure in this section.
	5. Governor valve sticking	5. Perform governor test. Service as required. If necessary, refer to the procedure in this section.
	6. Damaged intermediate servo	6. Air pressure check intermediate servo. If necessary, refer to the procedure in this section.
	7. Engine vacuum leak	7. Check engine vacuum lines. Service as necessary. If necessary, refer to Section 21-01. Check vacuum diaphragm unit. Service as necessary. Perform vacuum supply and diaphragm tests. If necessary, refer to the procedure in this section.

D5803-A10

DIAGNOSIS

TROUBLESHOOTING CHART
AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Rough/harsh/delayed 1-2 upshift (Cont'd)	8. Valve body bolts—loose/too tight	8. Tighten to specifications. If necessary, refer to Section 17-03.
	9. Valve body dirty/sticking valves	9. Determine source of contamination. Service as required. If necessary, refer to Section 17-03.
	10. Vacuum leak to modulator	10. Check vacuum lines to modulator. Service as required. If necessary, refer to the procedure in this section.
	11. Vacuum modulator diaphragm bent, sticking, leaks	11. Check modulator. Service as necessary. If necessary, refer to the procedure in this section.
Mushy/early/soft/slipping 1-2 upshift	1. Improper fluid level	1. Perform fluid level check. If necessary, refer to the procedure in this section.
	2. Incorrect engine performance	2. Refer to Section 21-07.
	3. Intermediate band out of adjustment	3. Adjust intermediate band. If necessary, refer to Section 17-03.
	4. Low main control pressure	4. Perform control pressure test. If necessary, refer to the procedure in this section.
	5. Valve body bolts loose/too tight	5. Tighten to specification. If necessary, refer to Section 17-03.
	6. Valve body dirty/sticking valves	6. Determine source of contamination. Service as required. If necessary, refer to Section 17-03.
	7. Governor valve sticking	7. Perform governor test. Service as required. If necessary, refer to the procedure in this section.

D5803-A11

DIAGNOSIS

TROUBLESHOOTING CHART
AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Mushy/early/soft/slipping 1-2 upshift (Continued)	8. Damaged intermediate servo or band	8. Perform air pressure test. Service as required. If necessary, refer to the procedure in this section.
	9. Polished, glazed band or drum	9. Service or replace as required. If necessary, refer to Section 17-03.
No 2-3 upshift	1. Low fluid level	1. Perform fluid level check. If necessary, refer to the procedure in this section.
	2. Low main control pressure to direct clutch	2. Perform control pressure test. If necessary, refer to the procedure in this section.
	3. Valve body bolts—loose/too tight	3. Tighten to specification. If necessary, refer to Section 17-03.
	4. Valve body dirty/sticking valves	4. Determine source of contamination, then service as required. If necessary, refer to Section 17-03.
	5. Direct clutch or reverse/high clutch assembly burnt/worn	5. Perform stall test. Determine cause of condition. Service as required. If necessary, refer to the procedure in this section.
Harsh/delayed 2-3 upshift	1. Incorrect engine performance	1. Check engine tune-up. If necessary, refer to Section 21-01.
	2. Engine vacuum leak	2. Check engine vacuum lines. Service as necessary. If necessary, refer to Section 21-01. Check vacuum diaphragm unit. Service as necessary. Perform vacuum supply and diaphragm tests. If necessary, refer to the procedure in this section.

D5803-A12

DIAGNOSIS

TROUBLESHOOTING CHART
AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Harsh/delayed 2-3 upshift (Continued)	3. Damaged or worn intermediate servo release and high clutch piston check ball	3. Air pressure test the intermediate servo. If necessary, refer to the procedure in this section.
	4. Valve body bolts—loose/too tight	4. Tighten to specification. If necessary, refer to Section 17-03.
	5. Valve body dirty/sticking valves	5. Determine source of contamination. Service as required. If necessary, refer to Section 17-03.
	6. Vacuum diaphragm or rod bent/sticking/leaks	6. Check diaphragm and rod. Replace as necessary. If necessary, refer to the procedure in this section.
Soft/early/mushy 2-3 upshift	1. Valve body bolts loose/too tight	1. Tighten to specification. If necessary, refer to Section 17-03.
	2. Valve body dirty/sticking valves	2. Determine source of contamination. Service as required. If necessary, refer to Section 17-03.
	3. Vacuum modulator diaphragm bent, sticking, leaks	3. Check diaphragm and rod. Replace as necessary. If necessary, refer to the procedure in this section.
Erratic shifts	1. Improper fluid level	1. Perform fluid level check. If necessary, refer to the procedure in this section.
	2. Poor engine performance	2. Check engine tune-up. If necessary, refer to Section 21-01.
	3. Valve body bolts—loose/too tight	3. Tighten to specification. If necessary, refer to Section 17-03.
	4. Valve body dirty/sticking valves	4. Determine source of contamination. Service as required. If necessary, refer to Section 17-03.

D5803-A13

DIAGNOSIS

TROUBLESHOOTING CHART
AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Erratic shifts (Continued)	5. Governor valve stuck	5. Perform governor test. Service as required. If necessary, refer to the procedure in this section.
	6. Oil collector body seal rings damaged	6. Service as required. If necessary, refer to Section 17-03.
Shifts 1-3 in D	1. Intermediate band out of adjustment	1. Adjust band. If necessary, refer to Section 17-03.
	2. Damaged intermediate servo and/or internal leaks	2. Perform air pressure test. Service front servo and/or internal leaks. If necessary, refer to the procedure in this section.
	3. Improper band or clutch application, or oil pressure control system	3. Perform control pressure test. If necessary, refer to the procedure in this section.
	4. Polished, glazed band or drum	4. Service or replace band or drum. If necessary, refer to Section 17-03.
	5. Valve body dirty/sticking valves	5. Clean, service or replace valve body. If necessary, refer to Section 17-03.
	6. Governor valve stuck	6. Perform governor test. Service as required. If necessary, refer to the procedure in this section.
Engine over-speeds on 2-3 shift	1. Linkage out of adjustment	1. Service or adjust linkage. If necessary, refer to Section 17-02.
	2. Improper band or clutch application, or oil pressure control system	2. Perform control pressure test. If necessary, refer to the procedure in this section.
	3. Damaged or worn high clutch and/or intermediate servo	3. Perform air pressure test. Service as required.

D5803-A14

DIAGNOSIS

TROUBLESHOOTING CHART
AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine over-speeds on 2-3 shift (Continued)	4. Intermediate servo piston seals cut/leaking	4. Perform air pressure test. If necessary, refer to the procedure in this section.
	5. Valve body dirty/sticking valves	5. Clean, service or replace valve body. If necessary, refer to Section 17-03.
Rough shudder 3-1 shift at closed throttle in D	1. Incorrect engine idle or performance	1. Tune and adjust engine idle. If necessary, refer to Section 21-01.
	2. Improper linkage adjustment	2. Service or adjust linkage. If necessary, refer to Section 17-02.
	3. Improper clutch or band application or oil pressure control system	3. Perform control pressure test. If necessary, refer to the procedure in this section.
	4. Improper governor operation	4. Perform governor test. Service as required. If necessary, refer to the procedure in this section.
	5. Valve body dirty/sticking valves	5. Clean, service or replace valve body. If necessary, refer to Section 17-03.
No forced downshifts	1. Kickdown cable out of adjustment	1. Service or adjust linkage. If necessary, refer to Section 17-02.
	2. Damaged internal kickdown linkage	2. Service internal kickdown linkage. If necessary, refer to Section 17-03.
	3. Improper clutch or band application, or oil pressure control system	3. Perform control pressure test. If necessary, refer to the procedure in this section.
	4. Dirty or sticking governor	4. Perform governor test. Service or replace governor. Clean screen. If necessary, refer to the procedure in this section.
	5. Valve body dirty/sticking valves	5. Clean, service, or replace valve body. If necessary, refer to Section 17-03. D5803-A15

DIAGNOSIS

TROUBLESHOOTING CHART
AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine over-speeds on 3–2 downshift	1. Linkage out of adjustment	1. Service or adjust linkage. If necessary, refer to Section 17-02.
	2. Intermediate band out of adjustment	2. Adjust intermediate band. If necessary, refer to Section 17-03.
	3. Damaged or worn intermediate servo	3. Air pressure test check the intermediate servo. Service servo and/or seals. If necessary, refer to the procedure in this section.
	4. Polished, glazed band or drum	4. Service or replace as required. If necessary, refer to Section 17-03.
	5. Valve body dirty/sticking valves	5. Clean, service or replace valve body. If necessary, refer to Section 17-03.
Shift efforts high	1. Manual shift linkage damaged/misadjusted	1. Check and adjust or service as required. If necessary, refer to Section 17-02.
	2. Inner manual lever nut loose	2. Tighten nut to specification. If necessary, refer to Section 17-03.
	3. Manual lever retainer pin damaged	3. Adjust linkage and install new pin. If necessary, refer to Section 17-03.
Transmission overheats	1. Improper fluid level	1. Perform fluid level check. If necessary, refer to the procedure in this section.
	2. Incorrect engine idle, or performance	2. Tune or adjust engine idle. If necessary, refer to Section 21-01.
	3. Improper clutch or band application, or oil pressure control system	3. Perform control pressure test. If necessary, refer to the procedure in this section.

D5803-A16

DIAGNOSIS

TROUBLESHOOTING CHART
AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Transmission overheats (Continued)	4. Restriction in cooler or lines	4. Service as necessary.
	5. Seized converter one-way clutch	5. Perform stall test. If necessary, refer to the procedure in this section. If stall test indicates problem with converter, remove and check one-way clutch. If necessary, refer to the procedure in this section.
	6. Valve body dirty/sticking valves	6. Clean, service or replace valve body. If necessary, refer to Section 17-03.
Poor vehicle acceleration	1. Poor engine performance	1. Check engine tune-up. If necessary, refer to Section 21-01.
	2. Torque converter one-way clutch locked up	2. Perform stall test. If necessary, refer to the procedure in this section. If stall test indicates problem with converter, remove and check one-way clutch. If necessary, refer to the procedure in this section.
Transmission noisy—valve resonance **NOTE:** Gauges may aggravate any hydraulic resonance. Remove gauge and check for resonance level.	1. Improper fluid level	1. Perform fluid level check.
	2. Linkage out of adjustment	2. Service or adjust linkage. If necessary, refer to Section 17-02.
	3. Improper band or clutch application, or oil pressure control system	3. Perform control pressure test.
	4. Cooler lines grounding	4. Free up cooler lines.
	5. Dirty or sticking valve body	5. Clean, service or replace valve body.
	6. Internal leakage or pump cavitation	6. Service as required.

D5803-A17

DIAGNOSIS

TRANSMISSION NOISY—OTHER THAN VALVE RESONANCE

TEST STEP		RESULT ▶	ACTION TO TAKE
A1	ROAD TEST		
	• Drive vehicle to determine if noise level is within acceptable limits.	(OK) ▶	Vehicle OK.
		(OK) ▶	GO to **A2**.
A2	PERFORM LINKAGE CHECK		
	• Check downshift cable and manual linkage adjustments. If necessary, refer to Section 17-02.	(OK) ▶	GO to **A3**.
		(OK) ▶	SERVICE and/or ADJUST linkage. REFER to Section 17-02. GO to **A1**.
A3	PERFORM FLUID CHECK		
	• Check fluid for proper level and/or contamination as described in this Section.	Fluid level No contamination. (OK) ▶	— GO to **A4**.
		Fluid level No contamination. (OK) ▶	FILL transmission until fluid level is between Add and Full. GO to **A1**.
		Fluid contaminated ▶	STOP! REMOVE, DISASSEMBLE, CLEAN and SERVICE transmission. FLUSH converter, cooler and cooler lines. REFER to appropriate Section in this Manual.

D5052-A1

DIAGNOSIS

TRANSMISSION NOISY — OTHER THAN VALVE RESONANCE (Continued)

TEST STEP	RESULT	ACTION TO TAKE
A4 CHECK BAND ADJUSTMENT • Check band adjustment. Refer to Section 17-03.	(OK) ▶	GO to **A5**.
	(OK) ▶	ADJUST bands as necessary. GO to **A1**.
A5 STALL TEST • Perform Stall Test. Check for noise at initial engagement for each gear.	Noise does not stop in any gear ▶	GO to **A6**.
	Noise stops in Low and R only ▶	REPLACE front planetary and/or one-way clutch.
	Noise stops in 2, D and R only ▶	REPLACE rear planetary.
	Noise stops in D only ▶	REPLACE both planetaries.
A6 SPEEDOMETER GEAR • Remove speedometer gear and check for noise.	Noise stops ▶	REPLACE speedometer gear.
	Noise does not stop ▶	CHECK extension housing bushing, seal or driveshaft. SERVICE or REPLACE as necessary.

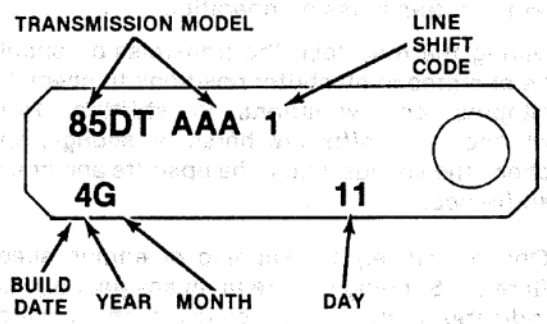
D5052-A2

DIAGNOSTIC PROCEDURES

TRANSMISSION IDENTIFICATION

The identification tag is located under the lower left extension housing attaching bolt. The tag shows the model prefix and suffix, assembly part numbers, and the built date code. The first line on the tag shows the transmission model prefix and suffix. A number appearing after the suffix indicates that internal parts have been changed after initial production start up.

NOTE: It is important that the codes on the transmission identification tag be checked when ordering parts or making inquiries about the transmission.



ON LOWER LEFT EXTENSION ATTACHING BOLT

D2628-L

FLUID LEVEL AND CONDITION CHECK

Low fluid level can cause a variety of conditions because it allows the pump to take in air along with the fluid. As in any hydraulic system, air bubbles make the fluid spongy; therefore, pressures will be low and build up slowly.

Improper filling can also raise the fluid level too high. When the transmission has too much fluid, the gears churn up foam and cause the same conditions which occur with a low fluid level.

In either case, the air bubbles can cause overheating, fluid oxidation, and varnish, which can interfere with normal valve, clutch, and servo operation. Foaming can also result in fluid escaping from the transmission vent where it may be mistaken for a leak.

During the fluid level check, observe the color and odor of the fluid. It should be dark reddish, not brown or black. Odor can sometimes indicate that there is an overheating condition or clutch disc or band failure.

Use an absorbent white facial tissue to wipe the dipstick. Examine the stain for evidence of solids (specks of any kind) and for antifreeze signs (gum or varnish on dipstick).

If specks are present in the oil or there is evidence of antifreeze, the transmission oil pan must be removed for further inspection. If fluid contamination or transmission failure is confirmed by further evidence of coolant or excessive solids in the oil pan, the transmission must be disassembled and completely cleaned and serviced. This includes cleaning the torque converter and transmission cooling system. It would be a waste of time to perform any further checks before cleaning and servicing the transmission.

Fluid Level Check

The automatic transmission should be checked at an operating temperature of 66 °C–77 °C (150 °F–170 °F), (dipstick is hot to touch). The operating temperature may be obtained by driving 24 to 32 km/h (15 to 20 mph) of city type driving with the outside temperature above 10 °C (50 °F).

Dipstick Reading: Fluid level on dipstick should be within the add and full marks.

If the transmission is not at an operating temperature of 66 °C to 77 °C (150 °F to 170 °F) and it becomes necessary to check the fluid level, the fluid may be checked at room temperature 21.1 °C to 35 °C (70 °F to 95 °F).

Dipstick Reading: Fluid level on the dipstick should be just below the add mark.

1. With the transmission in Park, engine at curb idle rpm, foot brakes applied, and vehicle on level surface, move the transmission selector lever through each range. Allow time in each range to engage transmission, return to Park, and apply parking brake fully.

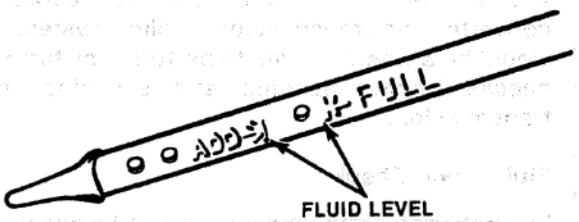
NOTE: Do not turn off the engine during the fluid level check.

DIAGNOSTIC PROCEDURES

FLUID LEVEL AND CONDITION CHECK (Continued)

2. Clean all dirt from the transmission fluid dipstick cap, before removing the dipstick from the filler tube.
3. Pull the dipstick out of the tube, wipe it clean, and push all the way back into the tube. **Be sure it is fully seated.**
4. Pull the dipstick out of the tube again and check the fluid level.

NOTE: The fluid level indication on the dipstick will be different at operating temperature (transmission hot) and room temperature (transmission cold).



FLUID LEVEL
BETWEEN THESE MARKS
AT OPERATING TEMPERATURE

D5805-A

Before adding fluid, be sure it meets Ford specification ESP-M2C138-CJ or Dexron II®, Series D or equivalent.

CAUTION: Use of a fluid other than specified above could result in transmission malfunction and/or failure.

If necessary, add enough fluid through the filler tube to raise the level to the correct position. Do not overfill the transmission, as this will result in foaming, loss of fluid through the vent, and possible transmission malfunction.

5. Install the dipstick, making sure it is fully seated in the tube.

MANUAL LINKAGE ADJUSTMENT

Refer to Section 17-02 for the manual linkage adjustment procedure.

DOWNSHIFT CABLE ADJUSTMENT

Refer to Section 17-02 for the throttle linkage adjustment procedure.

ROAD TEST

Prior to performing a road test, be sure that fluid level and condition and control linkage adjustments have been checked and are correct.

Observe engine performance when road-testing. A poorly tuned engine will have adverse effects on transmission operation.

During the road test, the transmission should be operated in all shifter positions to check for slipping and variations in shifting. Note whether the shifts are harsh or spongy, and check the speeds where the upshifts and downshifts occur.

Observe closely for slipping or engine speed flare-up. Slipping or flare-up in any gear usually indicates clutch, band, or overrunning clutch problems. If the condition is far advanced, an overhaul will probably be necessary to restore normal operation.

In most cases, the clutch or band that is slipping can be determined by noting the transmission operation in all selector positions and by comparing which internal units are applied in those positions. The Clutch and Band Application Chart and Shift Speed Chart provide a basis for road test analysis.

The road test is conducted through three basic driving conditions:

- Minimum throttle upshifts
- To detent shifts
- Through detent shifts

Proceed through each part of the test until a specific problem is found or until a no-problem conclusion is reached at the end of the test. If a problem is found, but it is not severe enough to conclude the test at that point, proceed to the end of test to make sure no other problems exist.

DIAGNOSTIC PROCEDURES

ROAD TEST (Continued)

CLUTCH AND BAND APPLICATION CHART

DRIVE POSITION	P	R	N		D				2			1
HOLDING MEMBERS					1	2	3		1	2		
Forward Clutch					•	•	•		•	•		•
Reverse/High Clutch		•					•					
Intermediate Band						•				•		
Low/Reverse Band		•										•
One-way Clutch					•				•			

D5806-A

SHIFT SPEED CHART

SHIFT	MPH	OUTPUT SHAFT RPM
1-2 minimum 10-15 in. Hg.	12-16	580-790
2-3 minimum 10-15 in. Hg.	17-24	845-1215
1-2 to detent 6 psi boost pressure	35-41	1740-2060
2-3 to detent 6 psi boost pressure	50-56	2480-2800
1-2 thru detent (WOT) 10 psi boost pressure	41-47	2038-2325
2-3 thru detent (WOT) 10 psi boost pressure	65-71	3275-3560
3-2 torque demand lockout 1 psi boost pressure	33-39	1640-1955
3-2 thru detent (kickdown) max. lockout 5 psi boost pressure	57-63	2850-3170
3-1 or 2-1 thru detent (kickdown) max. lockout 3 psi boost pressure	28-36	1425-1795
3-2 closed throttle coast out	11-17	530-845
2-1 closed throttle coast out	8-15	425-740
2-1 manual low closed throttle coast out	30-41	1530-2060

D5807-A

DIAGNOSTIC PROCEDURES

ROAD TEST (Continued)

Minimum Throttle Upshifts

To check the minimum throttle upshifts, give it just enough gas to barely accelerate the car. The diagnosis guide specifies above 12 inches of vacuum for all minimum throttle shifts. That means throttle pressure should be less than 69 kPa (10 psi)—not enough to raise control pressure or to cause modulated throttle pressure to act on the shift valves to delay upshifts.

When you move the selector to D, the forward clutch and governor supply system is charged with control pressure. The clutch applies, and with the one-way clutch holding, you are in first gear. Control pressure to the governor is dead-ended at the governor valve, so that there is no governor pressure.

As you drive off in first gear, you can be fairly sure the governor valve is not stuck in the maximum pressure position. If it was, the governor pressure would build up immediately, causing an immediate upshift to second.

Minimum Throttle 1-2 Upshift: When you reach about 12 mph, governor pressure should cause a shift. Since there's no modulated throttle pressure, the 1-2 shift valve train moves to charge the servo apply system. A smooth 1-2 shift at 19 km/h (12 mph) tells you the governor, and 1-2 shift valve train are free, and that the servo is applying the band. If the band doesn't apply, you'll stay in first gear and upshift to third at a higher speed.

Minimum Throttle 2-3 Upshift: Without increasing the throttle setting, check for the 2-3 upshift at specified speed. Now, governor pressure has risen high enough to overcome the 2-3 shift valve spring. (There is still no modulated throttle pressure.) The 2-3 shift valve moves and charges the reverse-and-high clutch system. The clutch applies and at the same time release pressure on the servo releases the band. The governor is still doing its job. The clutch circuit is hydraulically tight, and the 2-3 shift valve is free.

Closed Throttle 3-2, 2-1 Downshift: In D range also check the coast down shift. When the governor pressure decreases, the 2-3 and 1-2 shift valve train will move down from spring force. The forward clutch is still pressurized and the car is freewheeling.

Closed Throttle 2-1 Downshift: When you shift out of high gear in D to manual low (1), the transmission downshifts to second. If you start at a high enough road speed, 88 km/h (55 mph), and don't get slip on this shift, the line coasting boost valve is free.

Then, when governor pressure reduces as you coast down to 32 to 40 km/h (20 to 25 mph), you get a 2-1 downshift. This time, though, first gear is not freewheeling, since the low-and-reverse band is on. To be sure the low-and-reverse band is holding, accelerate to 40 km/h (25 mph) in first gear (1) and then test for engine braking.

"To Detent" Shifts

The "to detent" upshifts are full-throttle shifts. Throttle pressure is maximum and boosted throttle pressure acts on the modulator valve so maximum modulated throttle pressure is available to delay the upshifts. There is no downshift valve input to the shift valves, because you push the throttle only, until you feel the downshift spring.

To Detent 1-2 and 2-3: In D range, push the accelerator to the detent and hold it there. Check the upshift points. If they're to specifications and feel firm, the throttle valve, throttle booster valve, and throttle modulator valve are operating freely. Also, the governor still is doing a good job.

To Detent 3-2: At about 40 km/h (25 mph) in high gear, push the accelerator to the detent. This brings in boosted throttle pressure, which raises modulated throttle pressure enough to force the 3-2 shift.

"Through Detent" Shifts

Through the detent, we have the downshift system charged, exerting the maximum shift-delay force on the shift valves. The shifts will come in at the highest shift points. In D range, we can kick down to low gear only by going through the detent. Check the through detent-upshifts by pushing the accelerator to wide-open throttle in D and holding it there. Check the kickdown shift points by pushing the accelerator through the detent at the appropriate road speed. These shift points are a check on the downshift valve and on governor pressure output above 16 km/h (10 mph).

DIAGNOSTIC PROCEDURES

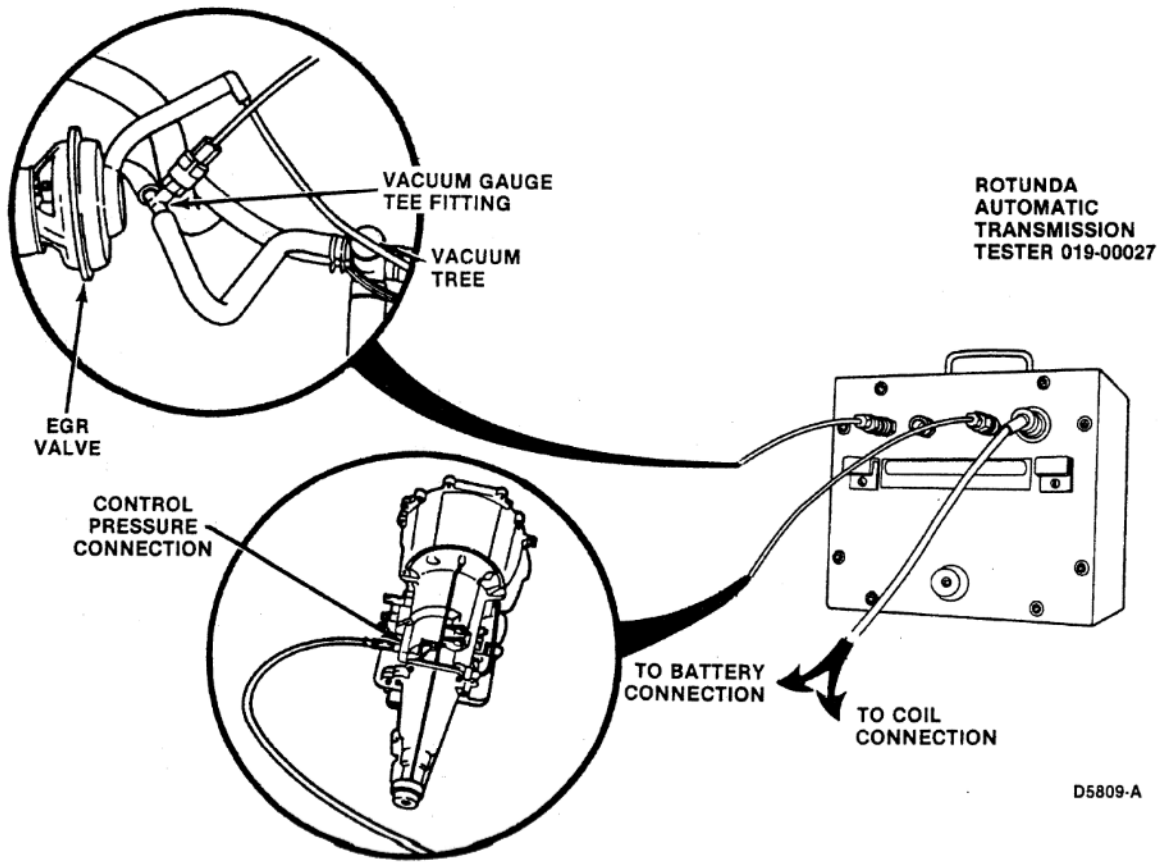
CONTROL PRESSURE TEST

Control pressure tests should be performed whenever there is slip in the gear train or the shift feel isn't right. Harsh, delayed upshifts often are the result of too much throttle pressure. The harshness comes from the throttle boost to control pressure and the delay from excess modulated throttle pressure. Of course, slip and no-drive conditions can be caused by too little control pressure—either from excess leakage in the system or sticking valves.

If you come back from a road test with a slipping hydraulic clutch, the control pressure test in the various ranges will probably tell you whether the slip is caused by a hydraulic leak or mechanical failure.

In the pressure tests, we begin by checking control pressure in all the ranges with no throttle pressure input. Then we check the control pressure rise when we pull the vacuum down and build throttle pressure.

Pressure Tester Connection

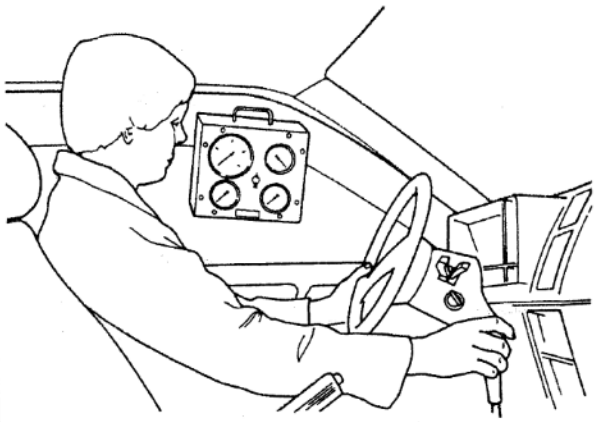


DIAGNOSTIC PROCEDURES

CONTROL PRESSURE TEST (Continued)

1. Adjust the engine idle speed to the specified rpm. If necessary, refer to Section 21-01. If the engine idle speed cannot be brought within limits, check the throttle and downshift linkage for a binding condition. If linkage is satisfactory, refer to Section 21-01 for further diagnosis.
2. Be sure the transmission fluid level and engine coolant level are correct; also that the transmission is at operating temperature.
3. Check and adjust throttle and manual linkage. If necessary, refer to Section 17-02.
4. Disconnect the hose at the vacuum modulator and check for a vacuum signal with the engine at idle.

   Hold a thumb over the end of the hose and check for vacuum. If the engine speeds up when the hose is disconnected and slows down as the thumb is held against the end of the hose, the vacuum source is satisfactory. Connect the vacuum hose.
5. Tee the vacuum hose from the tester into the manifold vacuum line to the transmission diaphragm.
6. Connect the tachometer leads to the coil distributor terminal and to ground.
7. Connect the tester leads to the battery.
8. Connect the pressure gauge hose to the control pressure tap at the left of the case.
9. Set the tachometer selector knobs as appropriate.
10. Place the installed tester on the window for visability.
11. Apply both the parking brakes and the service brakes during the test.
12. Operate the engine in the ranges shown in the Pressure Test Chart and at the manifold vacuum specified.



PRESSURE TEST

Engine RPM	Manifold Vacuum In. Hg.	Throttle	Range	PSI Record Actual	PSI Spec.
Idle	Above 12	Closed	P		51-61
			N		51-61
			D		51-61
			2		51-61
			1		51-61
			R		67-82
As Required	10	As Required	D		51-90
			R		83-143
As Required	Below 3	Wide Open	D		164-188
			2		164-188
			1		164-188
			R		276-304

Results_____

D5810-A

METRIC CONVERSION

psi	kPa	psi	kPa
51	352	90	621
61	420	164	1,131
67	462	188	1,296
82	565	276	1,903
83	572	304	2,096

DIAGNOSTIC PROCEDURES

CONTROL PRESSURE TEST (Continued)

NOTE: There are two methods of controlling the vacuum signal applied to the vacuum modulator. One is to perform the test using the engine vacuum under stall conditions. The second method is to use a remote vacuum source such as the one provided in a distributor tester or a hand-operated vacuum pump.

If you don't use an external vacuum source for the pressure rise tests, you'll be running at stall at fairly high rpm. This will heat up the engine and transmission considerably. To avoid overheating or damage:

- Don't operate at stall for more than five seconds per test.
- Release the throttle immediately in case of slip (see Stall Test).
- Operate the engine in neutral at 1000 rpm between tests for cooling.

13. Record the actual pressure in each condition and proceed to the governor check.

The Control Pressure Test Chart shows the most likely causes of abnormal pressures in various operating ranges. In cases where the pressure is low in a clutch or servo, its operation can be varified by removing the valve body and performing an air pressure test before disassembling the transmission. If necessary, refer to the procedure in this section.

Additional things to watch for during the control pressure tests:

Low Pressure at Idle

Low pressure in all the ranges at idle points is due to some problem in the pressure supply—low pump output; excessive leakage in the pump, case, or valve body; or a sticking regulator valve.

If the pressure is low in only certain ranges, there is probably a hydraulic leak in one of the systems that's charged in those ranges. For example, a leak in the forward clutch and governor system could cause low pressure in all forward ranges, but pressure would be good in reverse, park, and neutral. Of course, the leak would have to be bad enough that the pump volume could not keep up with the leakage.

High Pressure at Idle

High pressure at idle probably is caused by a throttle pressure input to the pressure booster valve. If the vacuum modulator diaphragm leaks, for instance, throttle pressure is going to be high and will boost control pressure.

To check where the vacuum leak is, remove the vacuum gauge tee and connect the gauge directly to the vacuum hose to see if vacuum is higher with the diaphragm out of the picture. If necessary, check vacuum at the other end of the hose to see if the hose leaks. Of course, if either the hose or diaphragm unit leaks, it must be replaced.

No Pressure Rise

If you don't get a pressure increase as vacuum drops, check the mechanical connection between the diaphragm and throttle valve. If the control rod isn't assembled, there's no spring force on the throttle valve so throttle pressure can't build up.

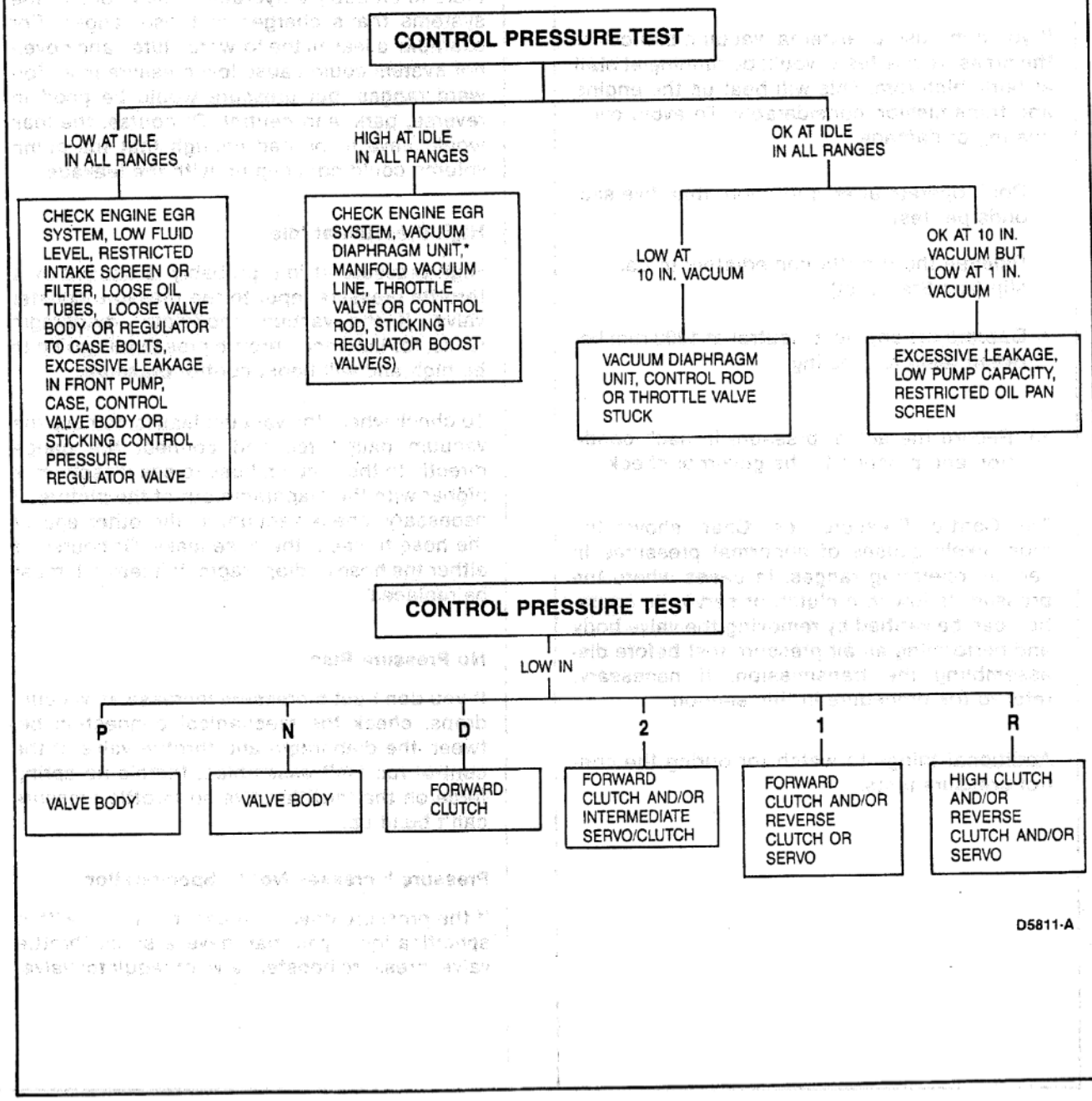
Pressure Increases Not to Specifications

If the pressure does increase, but is not within specifications, you may have a stuck throttle valve, pressure booster valve or regulator valve.

DIAGNOSTIC PROCEDURES

CONTROL PRESSURE TEST (Continued)

Control Pressure Test Results Chart



DIAGNOSTIC PROCEDURES

CONTROL PRESSURE TEST (Continued)

Governor Check

The governor can be checked at the same time as the Control Pressure Test is performed and in the same manner. This test checks that the governor is operating by observing if control pressure cuts back with increased road speed.

Raise the vehicle with an axle or frame hoist so that the rear wheels are clear of the floor. Disconnect and plug the vacuum line to the vacuum diaphragm unit. Connect an external vacuum supply to the diaphragm unit.

CAUTION: Never exceed 97 km/h (60 mph) speedometer speed.

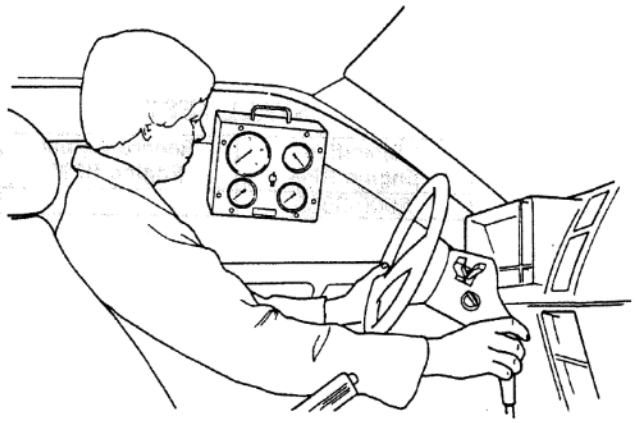
Place the transmission in manual 2; no load on the engine and apply 10 inches of vacuum to the vacuum diaphragm unit. Increase the speed slowly and watch the speedometer. Check the km/h (mph) at which the control pressure cutbacks occur. It should occur between 16 to 23 km/h (10 to 20 mph).

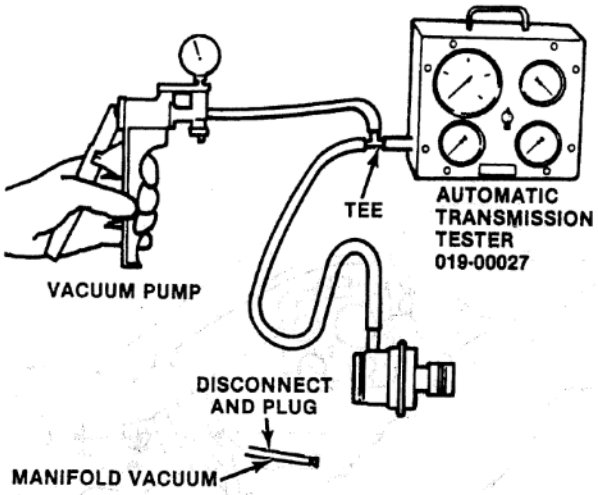
If the cutback speeds are okay, the governor is operating.

If the cutback doesn't occur at all, the governor isn't operating. It may need to be cleaned or replaced; or the filter screen may need cleaning to allow supply fluid to get to the governor valve.

One other possibility is that the cutback happens okay on one test and not the other. This would indicate a valve body problem. The valve body then should be removed and overhauled.

CAUTION: The rear suspension must not hang free. Support the rear suspension arms so that the halfshaft CV joint angles are at curb weight condition (5° to 9° shaft angle). Without support, the CV joint will operate at a very high angle resulting in possible damage to the joint.





GOVERNOR TEST

Cutback Speed
10″ Vacuum _____ MPH_____
0-2″ Vacuum _____ MPH_____

D5812-A

DIAGNOSTIC PROCEDURES

STALL TEST

The stall test is used to check for clutch or band slippage in the transmission, torque converter operation, and engine performance. The stall test consists of checking the maximum engine rpm at stall in D, 2, 1 and reverse.

The test should be done only with the engine coolant and transmission fluid at proper levels and at operating temperature, and with the kickdown linkage set properly.

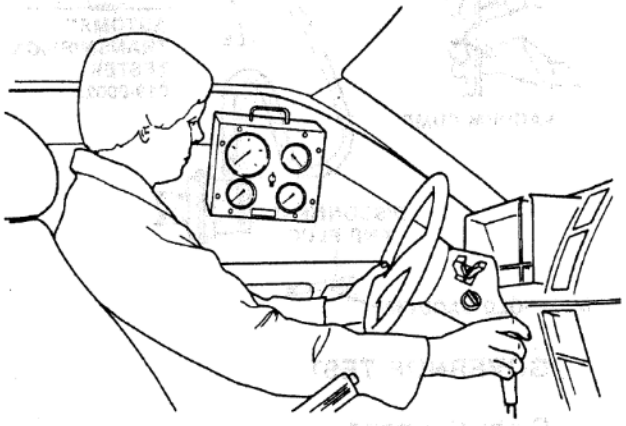
Apply the service and parking brakes firmly for each stall test.

1. Connect the tachometer to the engine and position it so it can be seen from the driver's seat.
2. Mark the specified rpm on the tachometer dial with a grease pencil to allow quick determination if the needle is off or at the mark.
3. In each gear range, press the accelerator to the floor and hold it just long enough to let the engine get to full rpm.

CAUTION: While making this test, do not hold the throttle open for more than five seconds at a time and after each range, move the selector lever to Neutral and run the engine at 1000 rpm for about 15 seconds to cool the converter before making the next test.

NOTE: Whenever the engine speed recorded by the tachometer exceeds the maximum limits, release the accelerator immediately because clutch or band slippage is indicated.

4. Record the rpm reading in each gear range.
5. Refer to the Stall Test Results Table for a summary of the possible conditions.



D5802-A

STALL TEST

Specified Engine RPM	Record Actual Engine RPM
3000-3300	

DIAGNOSTIC PROCEDURES

STALL TEST RESULTS TABLE

Selector Position	Stall Speeds High	Stall Speeds Low
D Only	Planetary one-way clutch	
D, 2 & 1	Forward clutch	
D, 2, 1 & R	General Problems Pressure Test	Converter stator one-way clutch or engine performance
R Only	High and/or reverse clutch or low reverse band or servo	

D5813-A

NOTE: A good stall test rpm in any range means the engine performance and torque converter one-way clutch are okay.

If the stall test indicates slipping, the range or ranges it occurs in give a clue to the cause. Since the transmission can't upshift at stall, the Clutch and Band Application Chart can be used to determine the slipping member(s) in each range.

RANGE	HOLDING MEMBERS APPLIED
D	Forward clutch and one-way clutch
1	Forward clutch and low-and-reverse band
2	Forward clutch and intermediate band
R	Reverse-and-high clutch and low-and-reverse band

D5814-A

Thus, the Stall Test Results Chart and Clutch and Band Application Chart present these possible causes of slip:

- Slip in all ranges—control pressure low
- Slip in D, 2 and 1—forward clutch
- Slip in D only—one-way clutch
- Slip in reverse only—reverse-and-high clutch or low-and-reverse band

DIAGNOSTIC PROCEDURES

STALL TEST (Continued)

If the stall test speeds are low and the engine is properly tuned, converter stator clutch problems are indicated. A road test must be performed to determine the exact cause of the trouble.

During the road test, watch for two different type malfunctions that can affect the torque converter one-way clutch.

A. The stator assembly freewheels in both directions.

B. The stator assembly remains locked up at all times.

Condition A

If the stator roller clutch becomes ineffective, the stator assembly freewheels at all times in both directions. With this condition, the vehicle will tend to have poor acceleration from a standstill. At speeds above 48 to 56 km/h (30 to 35 mph), the vehicle may act normally. If poor acceleration problems are noted, it should first be determined that the exhaust system is not blocked, the engine is in good tune, and the transmission is in first (1st) gear when starting out.

If the engine will freely accelerate to high rpm in Neutral (N), it can be assumed that the engine and exhaust systems are normal. Driving the vehicle in Reverse (R) and checking for poor performance will help determine if the stator is freewheeling at all times.

Condition B

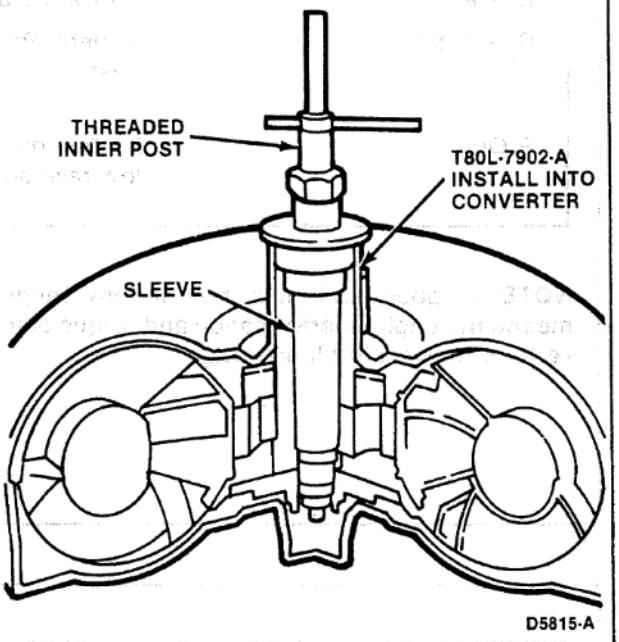
If the stator assembly remains locked up at all times, the engine rpm and vehicle speed will tend to be limited or restricted at high speeds. The vehicle performance when accelerating from a standstill will be normal. Engine overheating may be noted. Visual examination of the converter may reveal a blue color from the overheating that will result.

If either condition exists, the torque converter should be removed and checked using the following procedures.

TORQUE CONVERTER CHECKS

Endplay Check

1. Insert Tool T80L-7902-A, or equivalent, into the converter pump drive hub until it bottoms.



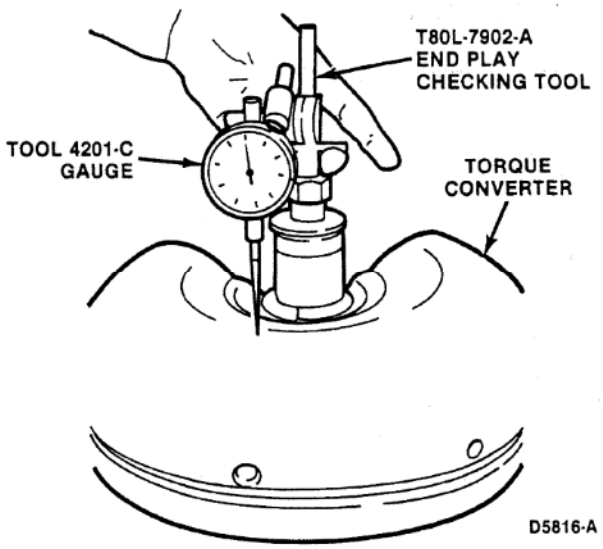
2. Expand the sleeve in the turbine spline by tightening the threaded inner post until the tool is securely locked into the spline.

3. Attach a dial indicator to the tool. Position the indicator button on the converter pump drive hub, and set the dial face at 0 (zero).

DIAGNOSTIC PROCEDURES

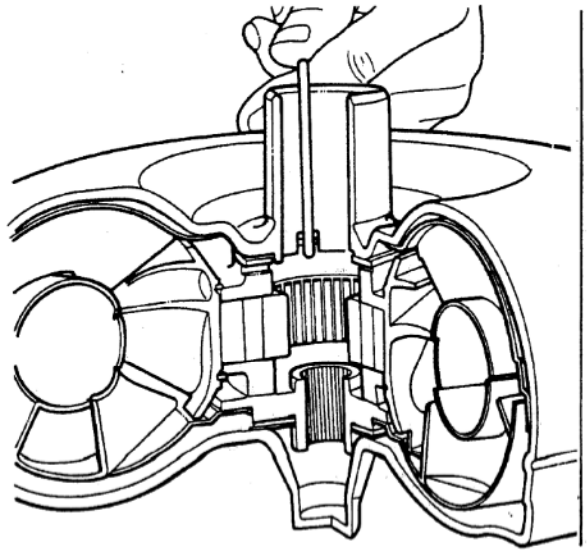
TORQUE CONVERTER CHECKS (Continued)

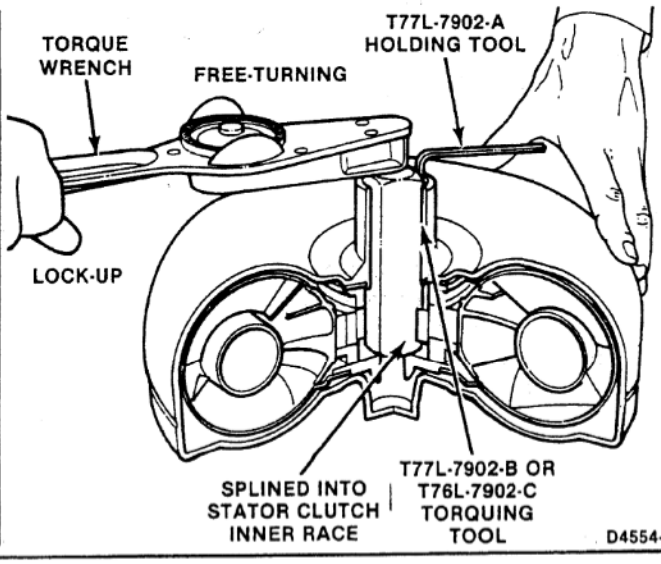
4. Lift the tool upward as far as it will go and note the indicator reading. The indicator reading is the total endplay, which the turbine and stator share. Replace the converter unit if the total endplay exceeds 0.58 mm (.023 in.) for a new/rebuilt converter or 0.127 mm (.050 in.) for a used converter.



Converter One-way Clutch Check

1. Insert the Converter Clutch Holding Tool T77L-7902-A, or equivalent, into one of the grooves in the stator thrust washer.
2. Insert Converter Clutch Torquing Tool T77L-7902-B, or equivalent, into the converter pump drive hub so as to engage the one-way clutch inner race..
3. Attach a torque wrench to the clutch torquing tool. With the holding tool held stationary, turn the torque wrench counterclockwise. The converter one-way clutch should lock up and hold a 14 N·m (10 lb-ft) force. The converter one-way clutch should rotate freely in a clockwise direction. Try the clutch for lockup and hold in at least five different locations around the converter.
4. If the clutch fails to lock up and hold a 13 N·m (10 lb-ft) torque, replace the torque converter.



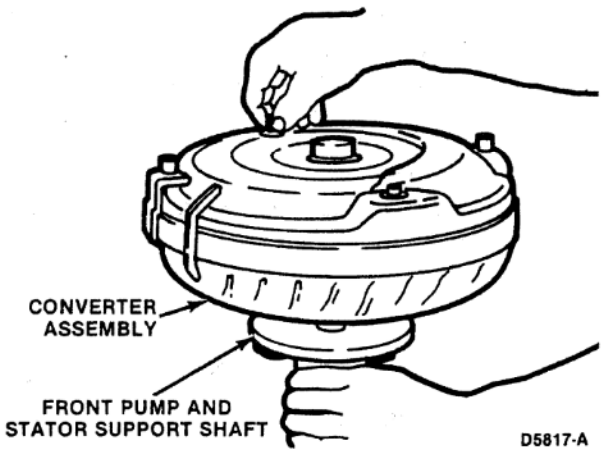


DIAGNOSTIC PROCEDURES

TORQUE CONVERTER CHECKS (Continued)

Stator to Impeller Interference Check

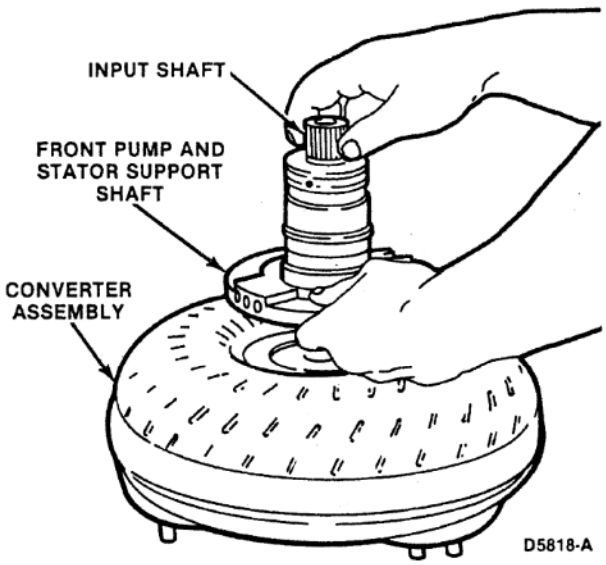
1. Position the front pump assembly on a bench with the spline end of the stator shaft pointing up.
2. Mount the torque converter on the pump with the splines on the one-way clutch inner race engaging the mating splines of the stator support. The converter hub will then engage the pump drive gear.
3. Hold the pump stationary, and try to rotate the converter counterclockwise. The converter should rotate freely without any signs of interference or scraping within the converter assembly.



4. If there is an indication of scraping, the trailing edges of the stator blades may be interfering with the leading edges of the impeller blades. In such cases, replace the torque converter.

Stator to Turbine Interference Check

1. Position the converter on the bench, front side down.
2. Install a front pump assembly to engage the mating splines of the stator support and stator, and pump drive gear lugs.
3. Install the input shaft, engaging the splines with the turbine hub.
4. Hold the pump stationary and attempt to rotate the turbine with the input shaft. The turbine should rotate freely in both directions without any signs of interference or scraping noise.



5. If interference exists, the stator front thrust washer may be worn, allowing the stator to hit the turbine. In such cases, replace the torque converter.

AIR PRESSURE CHECKS

A no-drive condition can exist, even with the correct transmission fluid pressure, because of an inoperative clutch or band. The inoperative units can be located through a series of checks by substituting air pressure for the fluid pressure to determine the location of the malfunction.

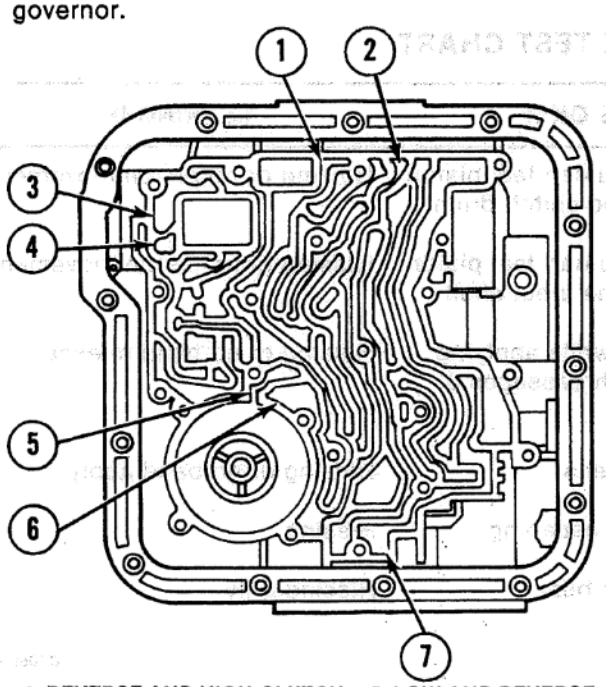
DIAGNOSTIC PROCEDURES

AIR PRESSURE CHECKS (Continued)

For example, when the selector lever is in Drive (D), a no-drive condition may be caused by an inoperative forward clutch or one-way clutch. When there is no-drive in 1, the difficulty could be caused by improper functioning of the forward clutch or low-reverse band and the one-way clutch. Failure to drive in reverse range could be caused by a malfunction of the reverse-high clutch or low-reverse band or clutch. In each case, refer to the applicable Band and Clutch Application Chart to relate faulty transmission operation to a specific hydraulic component.

When you have a slip problem but do not know whether it is in the valve body or in the hydraulic system beyond the valve body, the Air Pressure Tests can be very valuable.

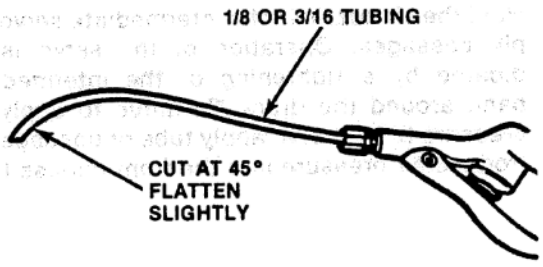
To make the air pressure checks, remove the fluid pan and the control valve body assembly. If necessary, refer to Section 17-03. The inoperative units can be located by introducing air pressure into the transmission case passages leading to the clutches, servos, and governor.



1. REVERSE-AND-HIGH CLUTCH
2. FOREWARD CLUTCH
3. INTERMEDIATE SERVO APPLY
4. INTERMEDIATE SERVO RELEASE
5. LOW-AND-REVERSE SERVO APPLY
6. LOW-AND-REVERSE SERVO RELEASE
7. MAIN PRESSURE TO GOVERNOR

D5820-A

The passages can be tested adequately with air pressure regulated at 275 kPa (40 psi). However, it may be necessary to use higher air pressure 620 kPa (90 psi) if there is difficulty in hearing the clutches apply. The air pressure can be more easily concentrated in a particular passage if the air gun is equipped with a fabricated nozzle as shown below.



NOZZLE FOR AIR PRESSURE TEST

D5819-A

If a servo or the accumulator does not operate and disassemble, clean and inspect to locate the source of the trouble. If air pressure applied to a clutch passage fails to operate the clutch or operates two clutches at once, check the fluid passages in the case and front pump to detect obstructions or damage.

Clutches

Apply air pressure to the transmission case forward clutch and reverse/high clutch passages. A dull thud can be heard when the clutch piston is applied. If no noise is heard, place your fingertips on the input shell and again apply air pressure to the forward or front clutch passage. Movement of the piston can be felt as the clutch is applied.

Governor

Apply air pressure to the control pressure to governor passage, and listen for a sharp clicking or whistling noise. The noise indicates governor valve movement.

DIAGNOSTIC PROCEDURES

AIR PRESSURE TESTS (Continued)

Reverse High Clutch

Apply air pressure to the reverse high clutch. A dull thud indicates that the reverse-high clutch piston has moved to the applied position. If no noise is heard, place your fingertips on the clutch drum and again apply air pressure to detect movement of the piston.

Intermediate Servo Apply and Release

Hold the air nozzle in the intermediate servo apply passages. Operation of the servo is indicated by a tightening of the intermediate band around the drum. Continue to apply air pressure to the servo apply tube or passage. Introduce air pressure into the front release tube or the intermediate servo release passage. The front or intermediate band should release the band against the apply pressure.

Low Reverse Servo Apply and Release

Apply air pressure to the rear servo apply passage. The low-reverse band should tighten around the drum if the servo is operating properly.

Apply air pressure to the servo release passage and listen for a hissing noise that may indicate a leaking seal. The air pressure check points and results are summarized in the Air Pressure Test Chart.

AIR PRESSURE TEST CHART

PASSAGE	TESTS OK IF	LEAKING IF
Reverse-and-High Clutch	Dull thud or you can feel piston movement at the clutch drum	Hissing or no piston movement
Forward Clutch	Dull thud or you can feel piston movement on the input shell	Hissing or no piston movement
Intermediate Servo Release	Band releases while applying pressure to both passages 3 and 4	Hissing or no band release
Low-and-Reverse Servo Apply	Rear band tightens	Hissing or no band apply
Low-and-Reverse Servo Release	No sound of air escaping	Hissing
Governor Supply	Click, whistle or buzz	Hissing only

D5069-A

DIAGNOSTIC PROCEDURES

VACUUM MODULATOR TESTS

The vacuum modulator assembly controls shift spacing and timing such that these will not be adversely affected by changes in engine performance at altitudes, as in the Denver, Colorado area.

The modulator assembly exerts force on the throttle valve as a function of engine intake manifold vacuum and local atmospheric pressure. The modulator assembly is composed of a flexible diaphragm, an aneroid bellows assembly, a calibration spring, and case.

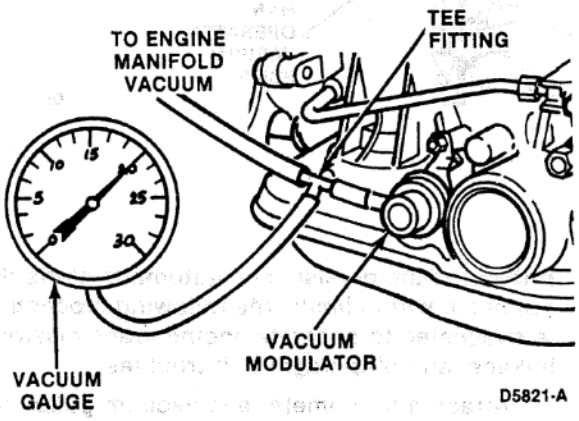
A failed vacuum modulator can cause one or more of the following complaints.

1. Harsh upshifts and downshifts.
2. Delayed upshifts.
3. Soft upshifts and downshifts.
4. Slips in low, drive, and reverse.
5. Transmission overheating.
6. Engine burning transmission oil.

If any one of the above complaints is encountered, the modulator must be checked.

Vacuum Supply Test

The vacuum supply to the vacuum modulator and the diaphragm itself must be checked. To check the supply, disconnect the vacuum line at the modulator and connect it to a vacuum gauge. With the engine idling, the gauge must have a steady acceptable vacuum reading for the altitude at which the test is being performed. If the vacuum reading is low, check for a vacuum leak or poor engine vacuum. If the vacuum reading is okay, rapidly accelerate the engine momentarily. The vacuum reading must drop rapidly at acceleration and return immediately upon release of the accelerator. If the vacuum reading does not change or changes slowly, the transmission vacuum line is plugged, restricted, or connected to a reservoir supply. Correct as required.

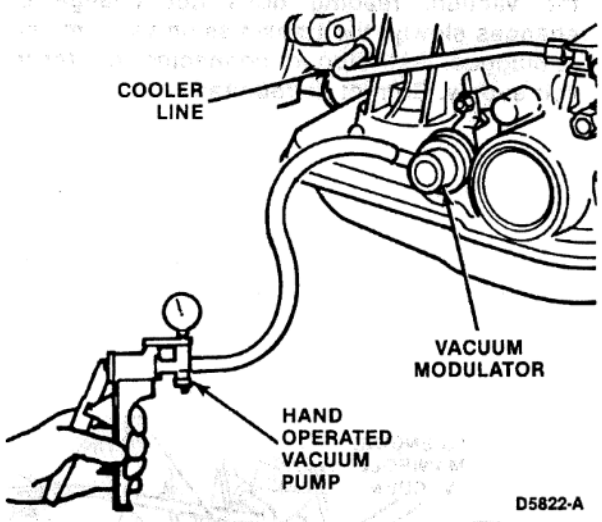


DIAGNOSTIC PROCEDURES

VACUUM MODULATOR TESTS (Continued)

Vacuum Diaphragm Functional Test

To check the vacuum modulator, attach a vacuum pump to diaphragm vacuum connector and apply 18 inches of vacuum. If the reading does not remain at 16 inches, the vacuum unit diaphragm is leaking. Replace the vacuum diaphragm unit. Also, if automatic transmission fluid is present in the vacuum side of the diaphragm or in the vacuum hose, the diaphragm is leaking and must be replaced.



If the problem persists and automatic shifts do not occur within limits, the following procedure is suggested to separate engine, transmission, linkage, and diaphragm unit troubles.

1. Attach a tachometer and vacuum gauge to the engine.
2. Attach a pressure gauge to the control pressure outlet at the rear of the transmission. If necessary, refer to the procedure in this section.
3. Firmly apply the parking brake and start the engine.
4. Adjust engine idle speed. If necessary, refer to Section 21-01. If engine idle speed cannot be brought within limits by adjustment at the idle adjustment screw, check the throttle and downshift linkage for a binding condition. If the linkage is satisfactory, check for vacuum leaks in the transmission diaphragm unit and its connecting tubes and hoses. Check all other vacuum-operated units (such as the power brake) for vacuum leaks.
5. At engine idle speed, read the engine vacuum gauge and the transmission control pressure gauge.

   The engine vacuum gauge should read a minimum of 18.0 inches. If the vacuum gauge reading is lower than 18.0 inches, an engine problem is indicated. Refer to Section 21-01 for further diagnosis.

   The transmission control pressure gauge at engine idle should read between 352 to 421 kPa (51 to 61 psi) in N, D1 and D2, and between 462 and 565 kPa (67 to 82 psi) in R. If the transmission control pressure is within limits, shift the transmission into D1 or D2 and firmly apply the service brakes. Advance the throttle until the engine vacuum gauge reading falls below 16 to 13.7 inches. As the vacuum gauge reading passes through the 16 to 13.7 inches range, the transmission control pressure should start to rise and continue to rise with throttle opening, until maximum control pressure for stall in D1 or D2 is obtained. In R, control pressure rise is not dependent on the diaphragm unit. When the selector lever is shifted into these positions and engine rpm is increased, control pressure should rise immediately and reach its maximum before engine speed reaches stall rpm. If the vacuum and pressure gauge readings follow the pattern described above, the diaphragm unit and transmission control pressure regulation system are operating properly.

   If transmission control pressure at idle is too low, too high, fails to rise with throttle opening, or is extremely erratic, follow the procedure given under the following appropriate heading.

DIAGNOSTIC PROCEDURES

VACUUM MODULATOR TESTS (Continued)

Control pressure is low. If control pressure at engine idle is low in all selector lever positions, trouble other than the diaphragm unit is indicated.

Transmission control pressure in P, R, and L is regulated entirely by the control pressure regulator valve and its spring. When control pressure at engine idle is low in all ranges, check for excessive leakage in the front oil pump, case, and control valve body.

Control pressure is high. If transmission control pressure at engine idle is too high in N, D1, and D2, the trouble may be in the diaphragm unit or its connecting tubes and hoses.

With the engine idling, disconnect the hose from the diaphragm unit and check the engine manifold vacuum. Hold a thumb over the end of the hose and check for vacuum. If the engine speeds up when the hose is disconnected and slows down as the thumb is held against the end of the hose, the vacuum source is satisfactory.

Stop the engine and remove the diaphragm unit and the diaphragm unit push rod. Inspect the push rod for a bent condition and for corrosion. Install the diaphragm unit in the case to prevent fluid loss, but leave the push rod out. With the push rod removed, the diaphragm unit cannot affect transmission control pressure. Start the engine and check control pressure at engine idle in N, D1, and D2. If control pressure is still too high, the trouble is in the transmission control system. If the pressure is now within limits, the diaphragm unit was not operating properly and should be replaced.

Control pressure does not rise with throttle opening. If transmission control pressure does not rise in D1 and D2 as engine vacuum falls below 16 to 13.7 inches, check the transmission's pressure rise capacity by shifting to R or L. In these positions, maximum control pressure should be obtained at not more than engine stall rpm.

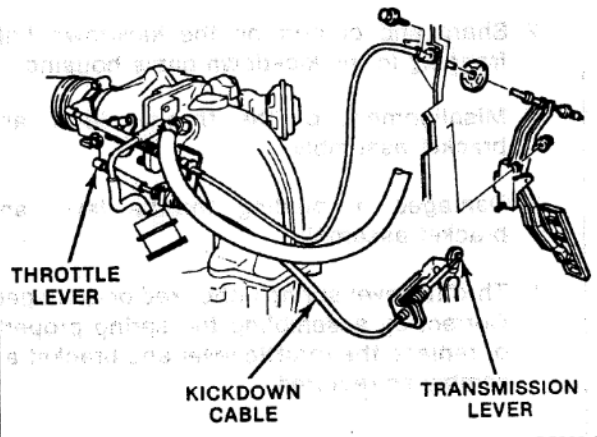
If pressure rise is normal in R and L, remove the hose from the diaphragm unit and check the hose and tubes as given above. If the vacuum reading at the diaphragm end of the hose is 18 inches Hg or greater, change the diaphragm unit and again check for pressure rise with throttle opening in D1 and D2. If control pressure does not rise now, the trouble is in the transmission. Check for excessive leakage in those components, which have control pressure in them in D1 and D2 but do not have control pressure in them in R and L.

Control pressure is extremely erratic. If Transmission control pressure is extremely erratic in N, D1, and D2, check the diaphragm unit tubes, hoses, and diaphragm push rod as given above under control pressure is high. If the vacuum source is satisfactory, replace the diaphragm unit and repeat the tests for transmission control pressure. If control pressure is still extremely erratic, the trouble is in the transmission. Clean and inspect the control valve body and pressure regulator.

KICKDOWN CABLE CHECKS

The kickdown cable controls line pressure for full throttle downshifts.

If the kickdown cable is broken, sticky, misadjusted, or the incorrect part for the model, the vehicle may exhibit various malfunctions.



DIAGNOSTIC PROCEDURES

KICKDOWN CABLE CHECKS (Continued)

Sticking or binding kickdown linkage can result in delayed or full throttle shifts. The kickdown cable must be free to travel to the full throttle position and return to the closed throttle position without binding or sticking.

Some binding or sticking of the kickdown cable and associated parts may only occur with the engine running and will not be noted or obtained with the engine off.

NOTE: Inspection of the kickdown cable and linkage for sticking or binding should be made with the engine running at idle speed, with the transmission selector in Neutral and the vehicle brakes set.

Pull the kickdown cable full travel beyond the throttle body lever pin that it attaches to and then release the cable. It should return to the closed throttle position against the throttle body lever pin. If the kickdown cable sticks and remains ahead of the throttle body lever pin, it may be caused by one or more of the following:

Possible Causes of Kickdown Malfunction

1. Sharp bends or a damaged kickdown cable housing. Correct by routing the cable or replace it if required.
2. Sharp end or burr on the kickdown link, fragging in the kickdown cable housing.
3. Misalignment of the throttle lever and bracket assembly.
4. Damaged or binding throttle lever and bracket assembly.
5. Throttle lever spring unhooked or damaged. Correct by assembling the spring properly or replace the throttle lever and bracket assembly as required.

Possible Results of Misadjustment

If the kickdown cable is adjusted **too long,** it may result in one of the two following conditions:

1. No detent downshifts.
2. Delayed or full throttle shifts by causing the transmission to operate in the high-pressure mode. The transmission senses a malfunction of the kickdown cable and associated parts. To prevent burning the clutches and band due to low line pressures, it will go into the high-pressure mode. Line pressures checked under the "minimum kickdown" conditions in Neutral and Drive will be in the range of the"full kickdown" pressures if the transmission is in the high-pressure mode. The complaint could be described as no upshifts, delayed, or sharp unshifts. The closed throttle 3-2 shifts may automatically occur as high as 72 km/h (45 mph).

   If the kickdown cable is adjusted **too short or not adjusted at all,** it will result in raising the line pressure and shift points. It may also limit the throttle valve opening to prevent full throttle operation.

FLUID LEAKAGE CHECKS

Before attempting to correct an oil leak, the actual source of the leak must be determined. In many cases, the source of the leak can be deceiving due to "wind flow" around the engine and transmission. Oil leaks around the engine and transmission are generally carried toward the rear of the car by the air stream. For example, a transmission oil fill pipe to case leak will sometimes appear as a leak at the rear of the transmission. In determining the source of a leak, proceed as follows:

1. Degrease the underside of the transmission.
2. Road-test the vehicle to get the transmission to operating temperature.
3. Inspect for the leak with the engine running.
4. With the engine off, check for oil leaks due to the raised oil level caused by drain back.

DIAGNOSTIC PROCEDURES

FLUID LEAKAGE CHECKS (Continued)

NOTE: Oil soluble aniline or fluorescent dyes premixed at the rate of 1/2 teaspoon of dye powder to 1/2 pint of transmission fluid have proved helpful in locating the source of fluid leakage. Such dyes may be used to determine whether an engine oil or transmission fluid leak is present, or if the fluid in the oil cooler leaks into the engine coolant system. A black light must be used with the fluorescent dye solution.

Check the speedometer cable connection at the transmission. Replace the rubber seal, if necessary.

Leakage at the oil pan gasket often can be stopped by tightening the attaching bolts to specifications. If necessary, replace the gasket.

Check the fluid filler tube connection at the transmission case or pan. If leakage is found here, install a new O-ring or tighten the fitting to specifications.

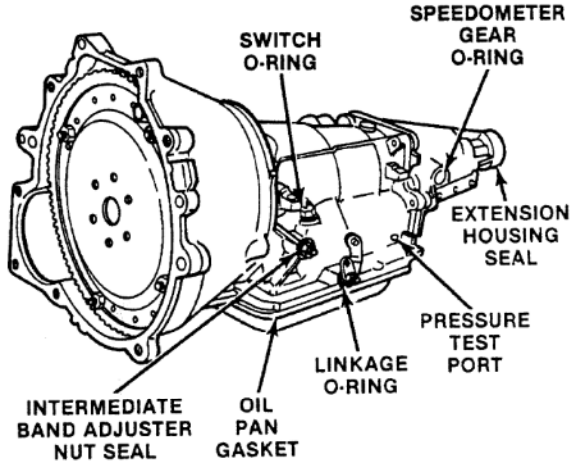
Check the fluid lines and fittings between the transmission and the cooler in the radiator tank for looseness, wear, or damage. If leakage cannot be stopped by tightening a fluid line tube nut, replace the damaged parts. When oil is found to be leaking between the case and the cooler line fitting, tighten the fitting to maximum specification. **Do not try to stop the oil leak by increasing the torque beyond specification. This may cause damage to the case threads.** If the leak continues, replace the cooler line fitting and tighten to specifications. The same procedure should be followed for oil leaks between the radiator cooler and cooler line fittings.

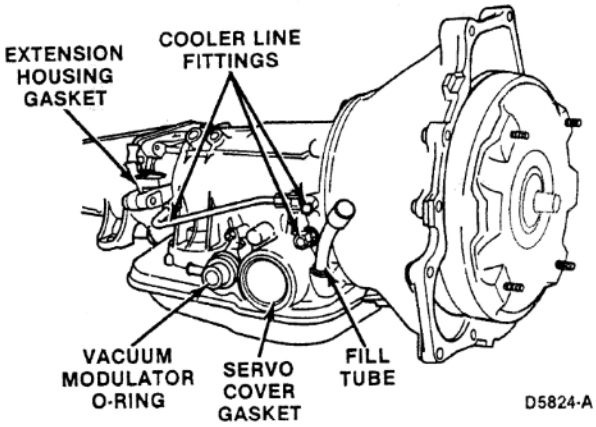
Check the engine coolant in the radiator. If transmission fluid is present in the coolant, the cooler in the radiator is probably leaking.

The cooler can be further checked for leaks by disconnecting the lines from the cooler fittings and applying 345 to 517 kPa (50 to 75 psi) air pressure to the fittings. Remove the radiator cap to relieve the pressure build up at the exterior of the oil cooler tank. If the cooler is leaking and/or will not hold pressure, the radiator must be replaced.

If leakage is found at either the downshift control lever shaft, or the manual lever shaft, replace either/or both seals.

Inspect the pipe plug on the left side of the transmission case at the front. If the plug shows leakage, tighten the plug to specifications, using Motorcraft sealing compound, or equivalent, on the threads. If tightening does not stop the leaks, replace the plug.

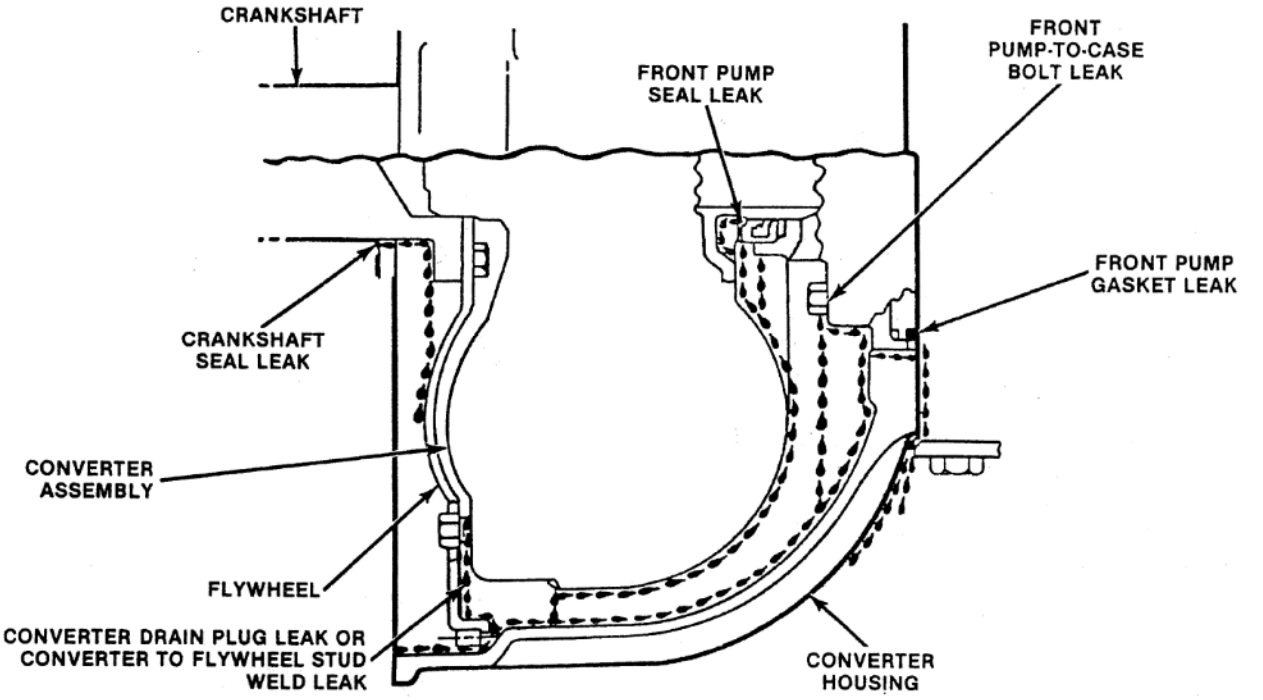




DIAGNOSTIC PROCEDURES

FLUID LEAKAGE IN CONVERTER AREA

In diagnosing and correcting fluid leaks in the front pump and converter area, use the following procedures to locate the exact cause of the leakage. Leakage at the front of transmission, as evidenced by fluid around the converter housing, may have several sources. By careful observation, it is possible, in many instances, to pinpoint the source of the leak before removing the transmission from the vehicle. The paths which the fluid takes to reach the bottom of the converter housing are shown.



DIAGNOSTIC PROCEDURES

FLUID LEAKAGE IN CONVERTER AREA (Continued)

1. Fluid leaking by the front pump seal lip will tend to move along the drive hub and onto the back of the converter assembly. Except in the case of a total seal failure, fluid leakage by the lip of the seal will be deposited on the inside of the converter housing only, near the outside diameter of the housing.

2. Fluid leakage by the outside diameter of the seal and front pump body will follow the same path, which the leaks by the front pump seal follow.

3. Fluid that leaks by a front pump to case bolt will be deposited on the inside of the converter housing only. Fluid will not be deposited on the back of the converter.

4. Leakage by the front pump to case gasket may cause fluid to be deposited inside the converter housing, or it may seep down between the front of the case and converter housing.

5. Fluid leakage from the converter drain plugs will appear at the outside diameter of the converter on the back face of the flywheel, and in the converter housing only near the flywheel.

6. Converter to flywheel stud weld leak.

   Engine oil leaks are sometimes improperly diagnosed as transmission front pump seal leaks. The following areas of possible leakage should also be checked to determine if engine oil leakage is causing the problem.

   a. Leakage at the rocker arm cover may allow oil to flow over the converter housing or seep down between the converter housing and cylinder block causing oil to be present in or at the bottom of the converter housing.

   b. Oil gallery plug leaks will allow oil to flow down the rear face of the block to the bottom of the converter housing.

   c. Leakage at the crankshaft seal will work back to the flywheel and then into the converter housing.

7. Fluid leakage from other areas, such as the power steering system forward of the transmission, could cause fluid to be present around the converter housing due to blow back or road draft. The following procedures should be used to determine the cause of the leakage before any repairs are made.

   a. Remove the transmission dipstick and note the color of the fluid. Original factory fill fluid is dyed red to aid in determining if leakage is from the engine or transmission. Unless a considerable amount of makeup fluid has been added or the fluid has been changed, the red color should assist in pinpointing the leak. Fluid used in the power steering system has a yellowish-green dye. Since road draft may cause leaking power steering fluid to be present on the transmission, this leakage, if present, should be eliminated before checking the transmission for fluid leakage.

   b. Remove the converter housing cover. Clean off any fluid from the top and bottom of the converter housing, front of the transmission case, and rear face of the engine and engine oil pan. Clean the converter area by washing with a suitable non-flammable solvent, and blow dry with compressed air.

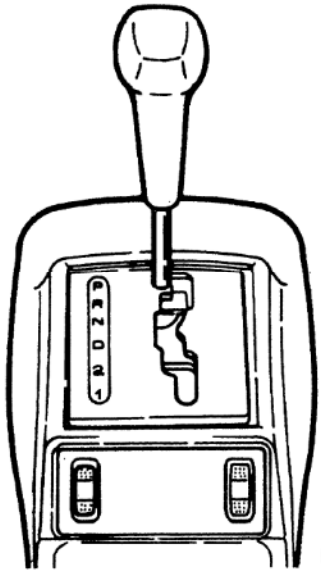
   c. Wash out the converter housing, the front of the flywheel, and the converter drain plugs. The converter housing may be washed out using cleaning solvent and a squirt-type oil can. Blow all washed areas dry with compressed air.

   d. Start and run the engine until the transmission reaches its normal operating temperature. Observe the back of the block and top of the converter housing for evidence of fluid leakage. Raise the vehicle on a hoist and run the engine at fast idle, then at engine idle, occasionally shifting to the Drive and Reverse ranges to increase pressure within the transmission. Observe the front of the wheel, back of the block (in as far as possible), and inside the converter housing and front of the transmission case. Run the engine until fluid leakage is evident and the probable source of leakage can be determined.

SECTION 17-02 SHIFT CONTROL LINKAGE

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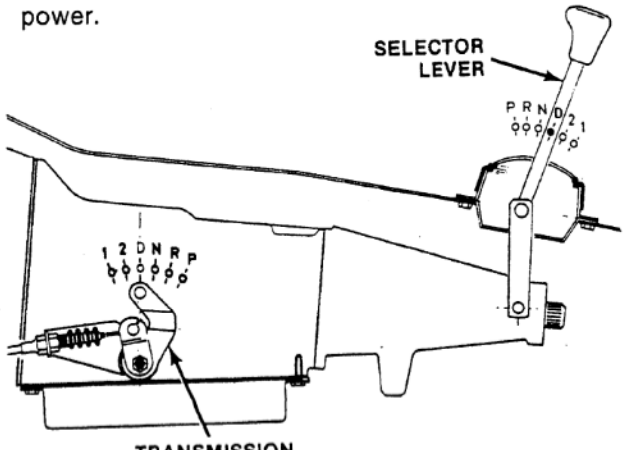
DESCRIPTION

Shift control linkage includes the driver-operated transmission gear selector mechanism and the transmission downshift cable. The downshift cable, located under the hood, connects the throttle body lever to the transmission downshift lever. The transmission selector lever allows the driver to select one of six gear shift positions.

When the gear selector lever is moved to one of the six positions, the linkage and levers are actually positioning the manual valve in the transmission shift control valve body. This valve acts as a master control that will match transmission operation to gear selector position. Internal linkage connects the manual valve to a shaft which extends through the side of the transmission case to an external shift lever. An adjustable rod connects this lever to the selector shift lever. Additional linkage connects the selector shift lever to the driver's gear selector lever.

Incorporated with this linkage are the shift interlock and shift gate. The pattern on the selector lever bezel and the shift mechanism housing is the shift gate. The shift interlock is part of the linkage connecting the gear selector lever to the selector shift lever. The interlock forces the driver to push down on the gear selector lever before moving into reverse from park or into park from reverse.

The downshift cable is also connected to an external lever on the left side of the transmission. The shaft connected to this lever extends through the case to the throttle pressure control valve. When the accelerator pedal is pushed to the wide-open throttle position, the levers and cable will reposition the throttle valve in the valve body. The transmission will downshift to the next lower gear for increased acceleration power.

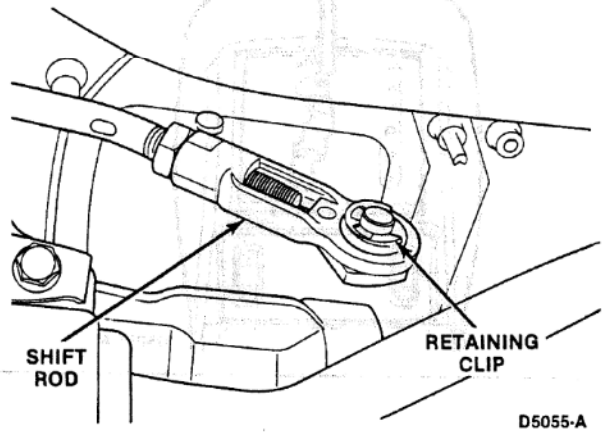


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ADJUSTMENTS

GEAR SELECTOR ROD

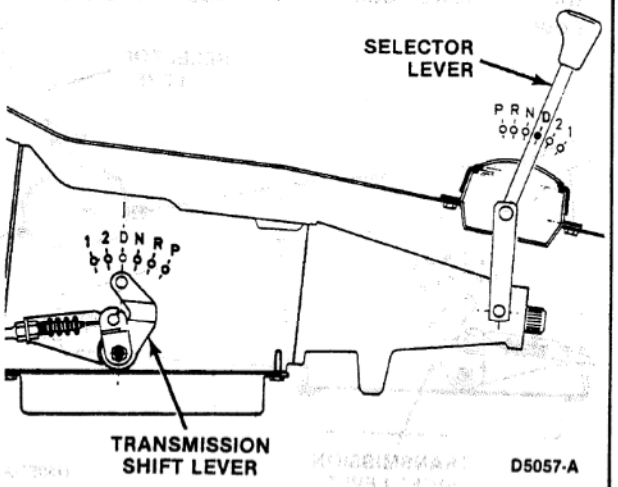
1. Raise the vehicle.
2. Remove the retaining clip and disengage the shift rod from the selector lever.



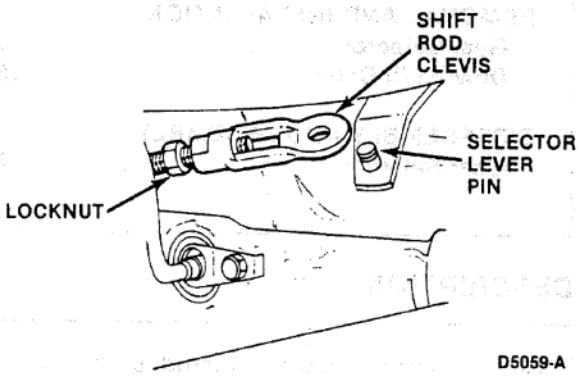
3. Rotate the transmission shift lever as far as possible toward the front of the vehicle.

   This is the DRIVE "1" or manual LOW position.

4. Rotate the transmission shift lever two detent positions toward the rear of the vehicle. This is the DRIVE or "D" position.



5. Lower the vehicle.
6. Position the selector lever in the "D" position.
7. Raise the vehicle.
8. Without moving the transmission or selector levers, attempt to slide the shift rod clevis over the selector lever pin.



- If the clevis slides onto the pin, the linkage is properly adjusted.
- If the clevis does not slide onto the pin, loosen the locknut and thread the clevis in or out to obtain the proper fit.

  After making the adjustment, tighten the clevis locknut.

9. Install the selector rod retaining clip.
10. Lower the vehicle.

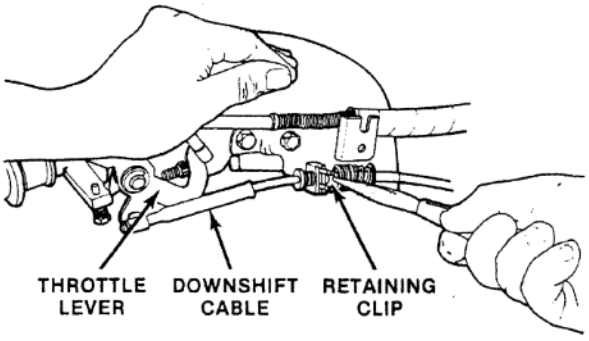
CAUTION: Make sure the linkage adjustment has not affected operation of the neutral safety switch. With the parking brake and service brakes applied, try to start the engine in each gearshift position. The engine must crank only in the "N" (neutral) and "P" (park) positions. If the engine cranks in any of the other shift positions, check the linkage adjustment and neutral safety switch operation.

ADJUSTMENTS

DOWNSHIFT CABLE

NOTE: Make sure the ignition key is in the OFF position before making this adjustment.

1. Using a pair of pliers, remove the cable retaining clip located near the throttle body routing bracket.



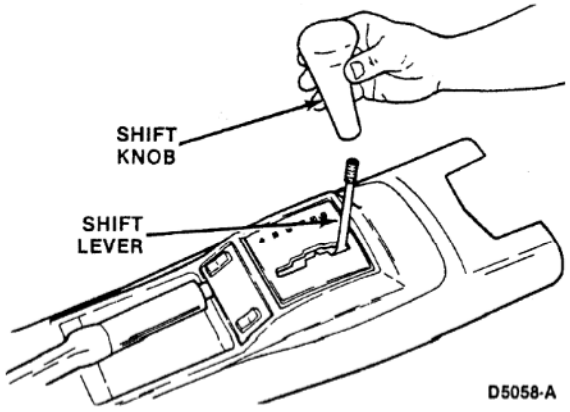
2. Rotate the throttle body lever to the wide-open position.
3. While holding the lever in the wide-open position, install the cable clip and release the lever.

REMOVAL AND INSTALLATION

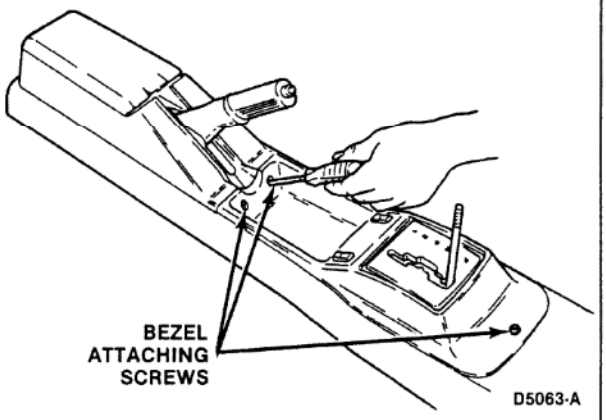
GEAR SELECTOR

Removal

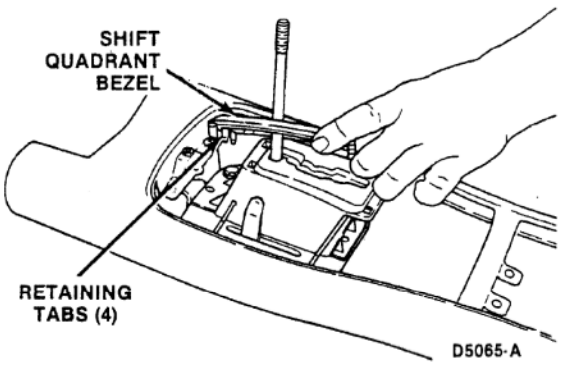
1. Remove the knob from the shift lever.



2. Remove the console bezel attaching screws.



3. Lift the bezel and, if equipped with power windows, disconnect the wiring connectors from the power window switches.
4. Remove the bezel.
5. Remove the shift quadrant bezel. Pull straight up on the bezel to disengage the lock tabs.

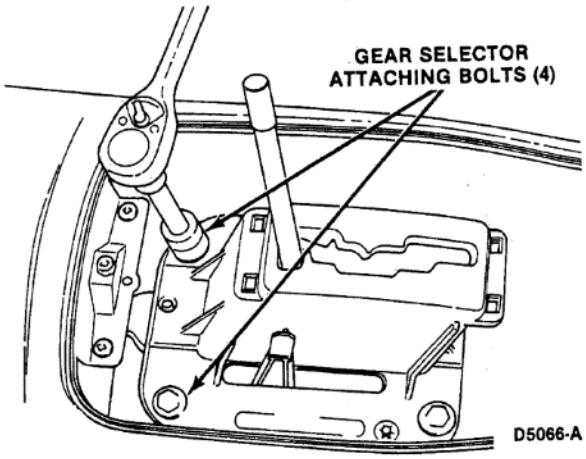


REMOVAL AND INSTALLATION

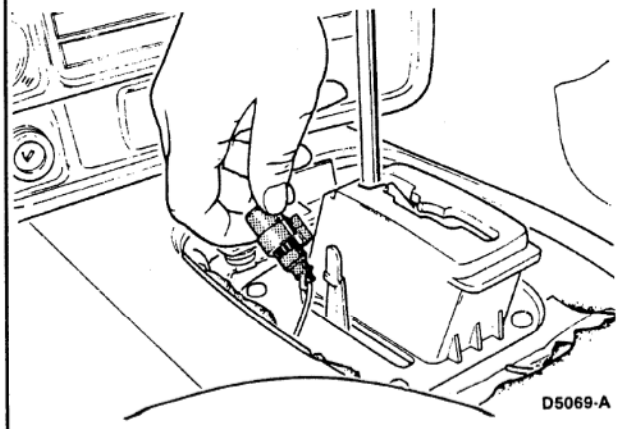
GEAR SELECTOR

Removal (Continued)

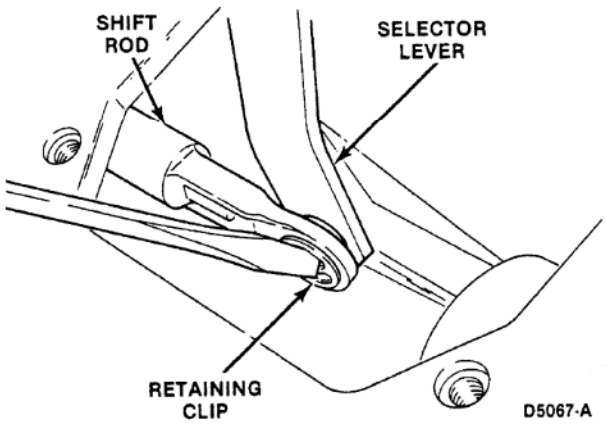
6. Remove the gear selector attaching bolts.



7. Remove the gear selector light from the selector lever guide bracket.



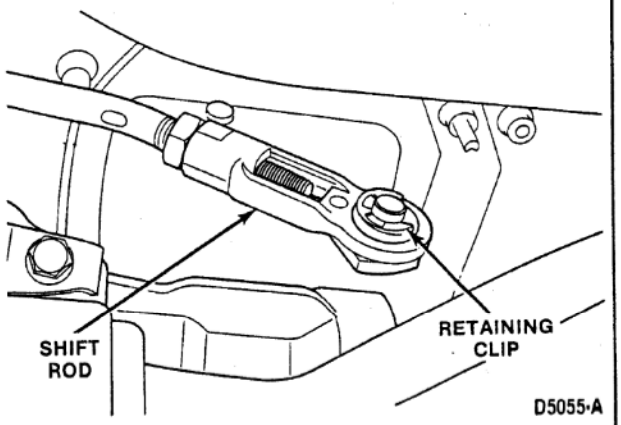
8. Raise the gear selector and remove the shift rod retaining clip.



9. Remove the gear selector.

Installation

1. Position the gear selector and install the attaching bolts.
2. Raise the vehicle and connect the shift rod to the shift lever using the retaining clip.



REMOVAL AND INSTALLATION

GEAR SELECTOR

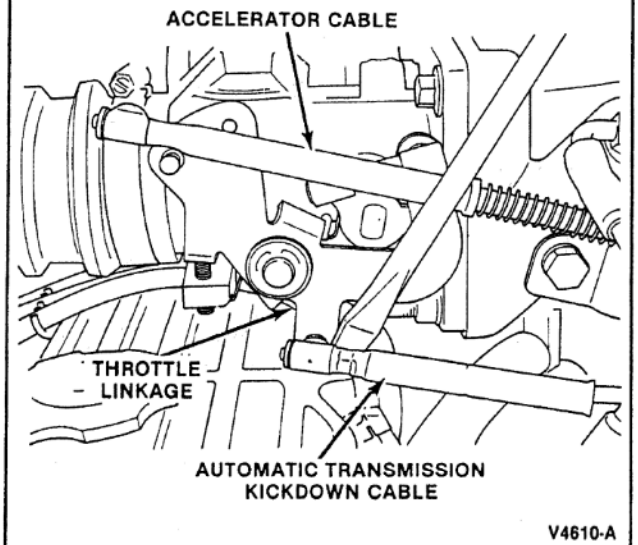
Installation (Continued)

3. Install the gear selector light on selector lever guide bracket.
4. Install the shift quadrant bezel.
5. Position the console bezel over the shift lever and connect the wiring to the power window switches (if equipped).
6. Position the console bezel and install the attaching screws.
7. Install the shift knob.

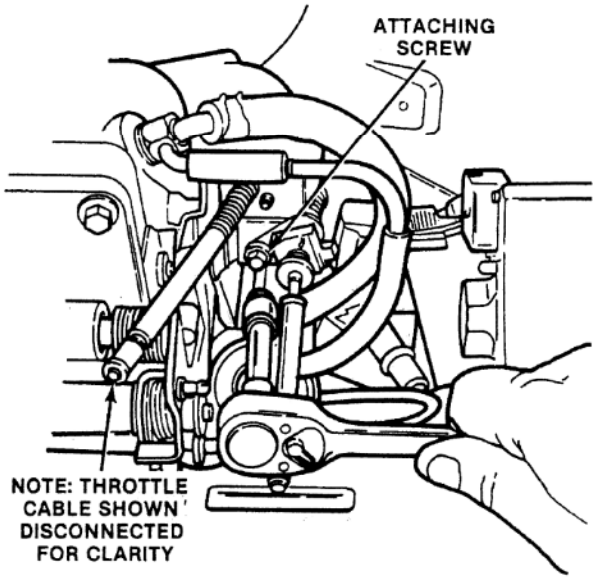
DOWNSHIFT CABLE

Removal

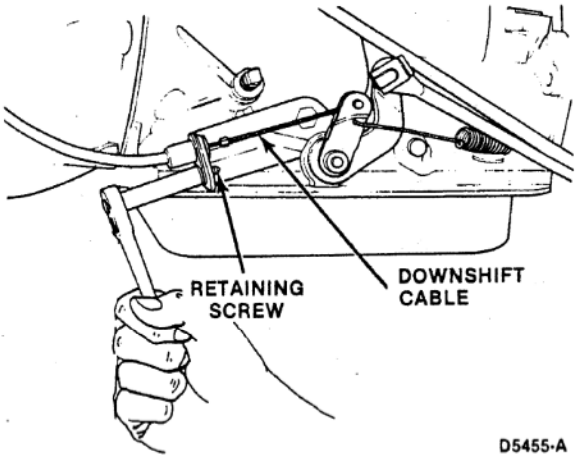
1. Disconnect the cable at the throttle body lever.



2. Remove the screw attaching the downshift cable casing to the throttle body routing bracket.



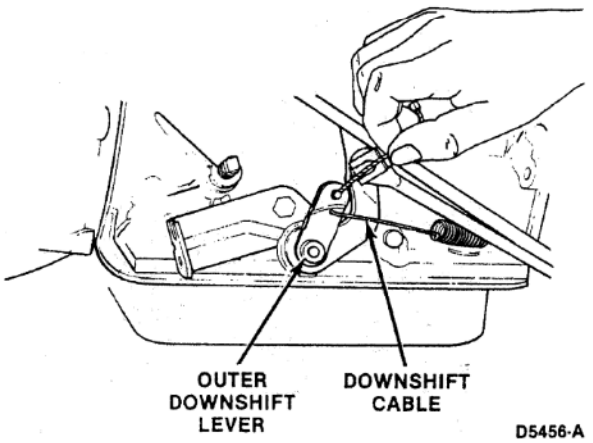
3. Raise the vehicle.
4. Remove the screw attaching the cable casing to the transmission routing bracket.



REMOVAL AND INSTALLATION

DOWNSHIFT CABLE
Removal (Continued)

5. Disconnect the cable at the transmission downshift lever and remove the cable.

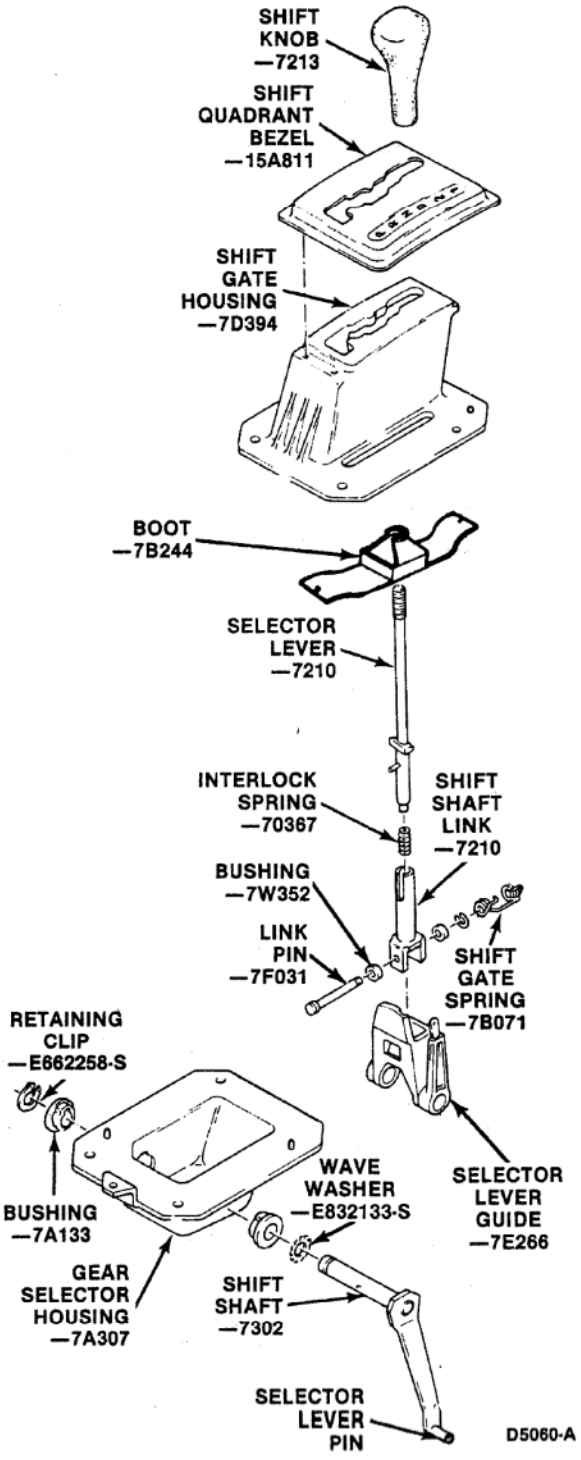


Installation

1. Route the cable through the engine compartment to the transmission routing bracket.
2. Position the cable casing on the transmission routing bracket and install the attaching screw.
3. Connect the cable to the transmission lever.
4. Lower the vehicle.
5. Position the cable casing on the throttle body routing bracket and install the attaching screw.
6. Connect the cable to the throttle body lever.
7. Adjust the downshift cable. If necessary, refer to the procedure in this section.

DISASSEMBLY AND ASSEMBLY

GEAR SELECTOR DISASSEMBLED VIEW

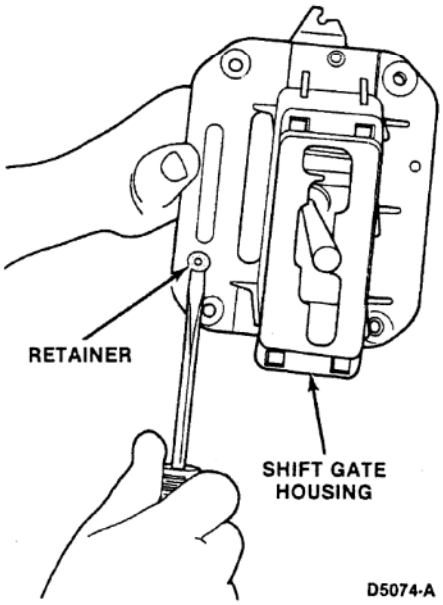


DISASSEMBLY AND ASSEMBLY

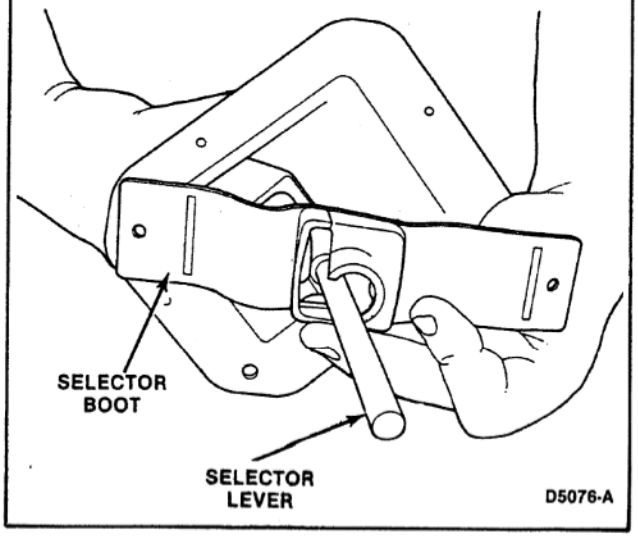
GEAR SELECTOR

Disassembly

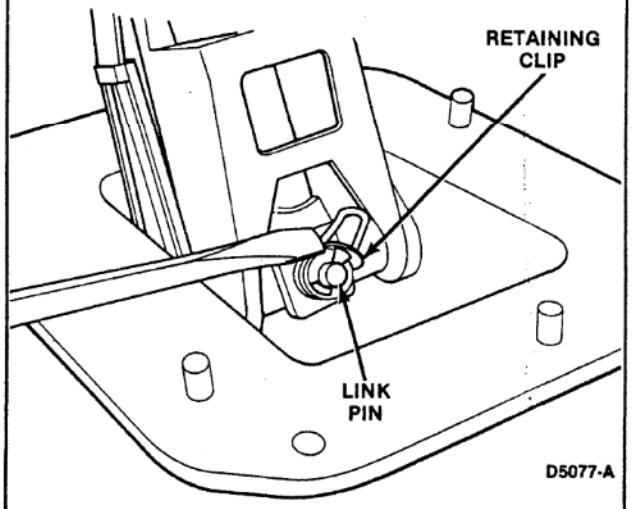
1. Using a screwdriver, remove the shift gate housing retainers and separate the shift gate housing from the gear selector housing.



2. Remove the boot from the selector assembly.

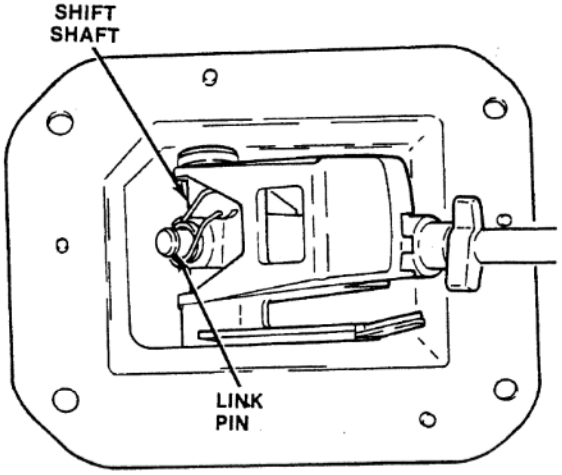


3. Remove the link pin retaining clip.



4. Remove the link pin and bushings.

   Use pliers to pull the link pin out of the shift shaft.

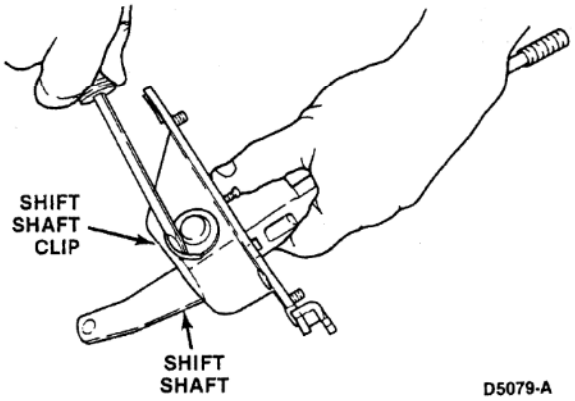


DISASSEMBLY AND ASSEMBLY

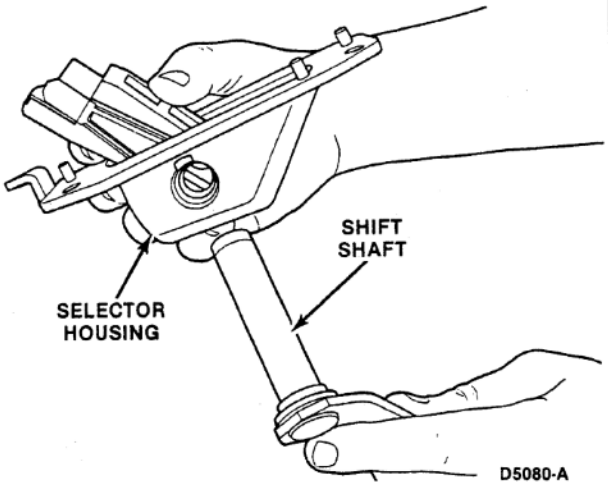
GEAR SELECTOR

Disassembly (Continued)

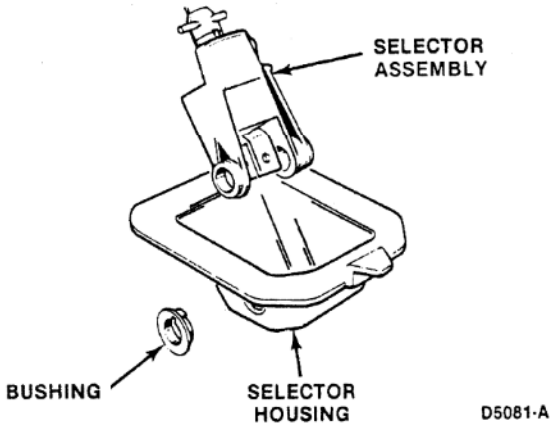
5. Remove the shift shaft retaining clip.



6. Pull the shift shaft out of the gear selector housing.

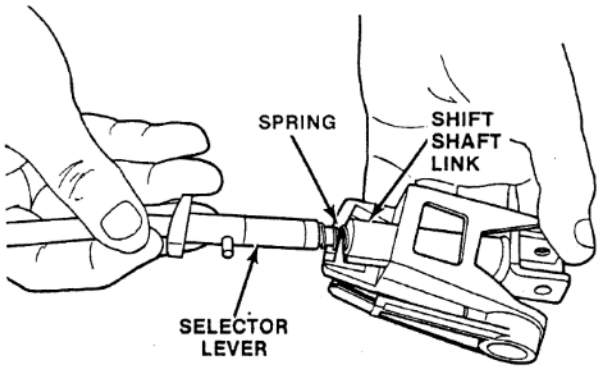


7. Remove the selector assembly from the selector housing.



8. Remove the shift shaft bushing from the gear selector housing.

9. Remove the selector lever and interlock spring from the shift shaft link.

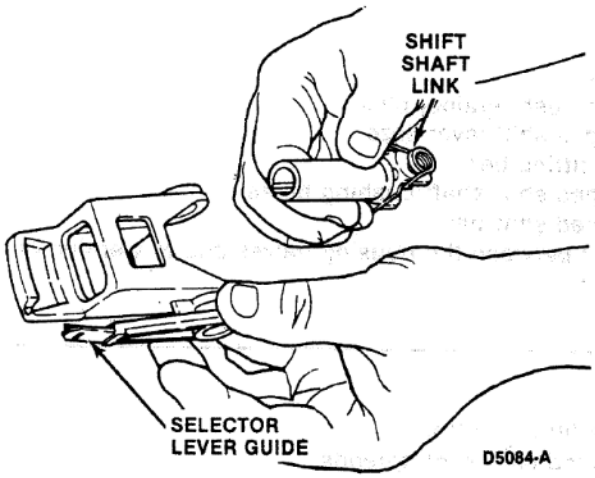


DISASSEMBLY AND ASSEMBLY

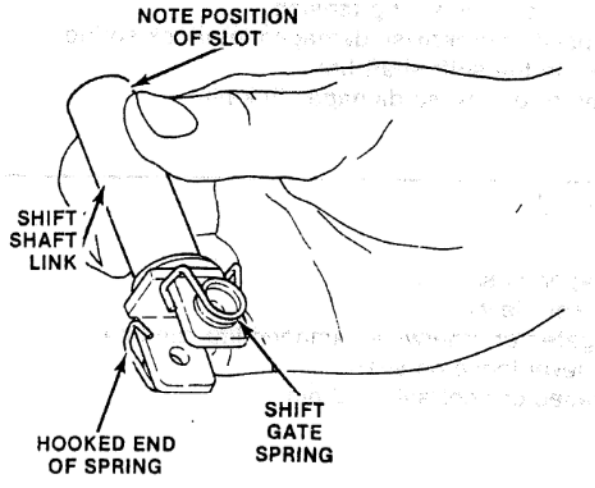
GEAR SELECTOR

Disassembly (Continued)

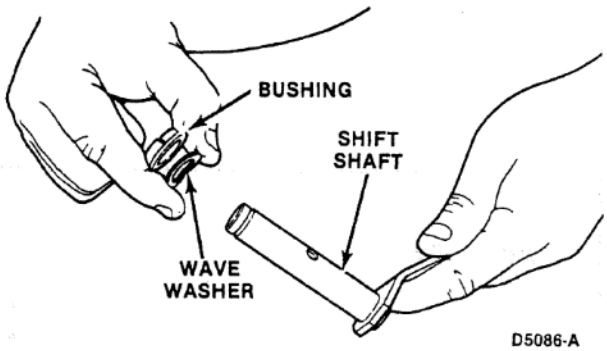
10. Remove the shift shaft link from the selector lever guide.



11. Remove the shift gate spring from the shift shaft link.



12. Remove the bushing and wave washer from the shift shaft.



DISASSEMBLY AND ASSEMBLY

SHIFT CONTROL LINKAGE

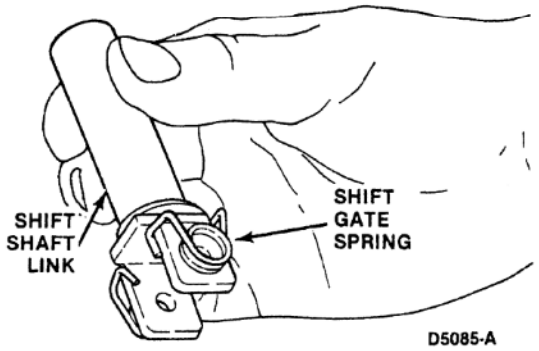
COMPONENT	CHECK FOR:
HOUSINGS	• Cracks • Broken push retainer pins • Damaged shift lever bezel • Loose fitting bezel • Damaged shift shaft bushing holes • Damaged shift gate • Poor fit between the housing halves due to warping or twisting
SHIFT LEVER	• Loose fitting shift knob • Damaged shift knob threads • Broken or missing interlock pin • Cracked or otherwise damaged selector lever guide • Torn or otherwise damaged selector lever boot
SELECTOR LEVER LINK	• Worn or broken link pin bushing • Worn interlock pin slot • Elongated or otherwise damaged link pin holes • Loss of shift gate spring tension • Broken or otherwise damaged shift gate spring • Loss of interlock spring tension • Collapsed or otherwise damaged interlock spring • Cracks in the shift shaft link • Broken or otherwise damaged link pin
SHIFT SHAFT	• Damaged bushings • Bent shift lever • Elongated or otherwise damaged link pin hole • Shift lever loose on shaft • Damaged or bent shift rod pin

DISASSEMBLY AND ASSEMBLY

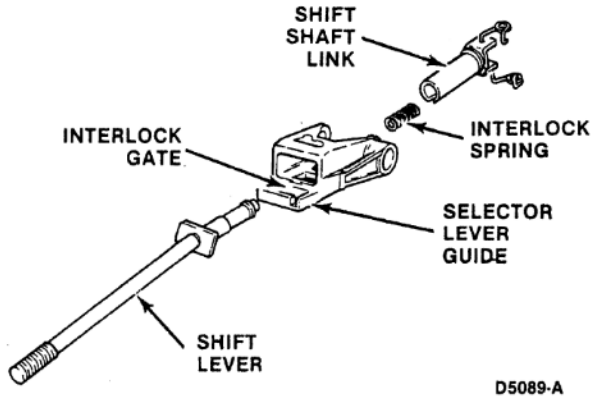
Assembly

1. Position the shift gate spring on the shift shaft link.

   Use the slot at the top of the link as reference point and install the spring coils over the link pin holes with the hooked ends on the right side of the slot.



2. Position the shift lever in the selector lever guide with the interlock pin in the interlock gate.



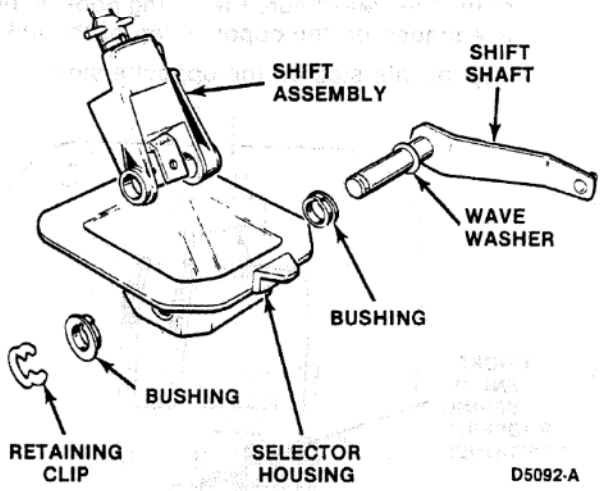
3. Install the interlock spring on the shift lever.

4. Install the shift shaft link on the shift lever.

   Make sure the slot in the link is aligned with the interlock pin on the shift lever.

5. Position the selector lever guide, selector lever and shift shaft link in the selector housing as an assembly.

   Make sure the shift indicator light bracket is on the left side of the housing.



6. Install the wave washer and bushing on the shift shaft.

7. Slide the shift shaft through the selector housing, selector lever guide and shift shaft link.

   Push down on the selector lever, as necessary, to align the parts with the shaft and make sure the bushing tab engages the slot in the housing.

8. Install the remaining shift shaft bushing.

9. Install the shift shaft retaining clip.

10. Install a bushing on the link pin.

11. Push the link pin through the shift lever link and shift shaft.

    Push the pin from the front of the housing and align the coils of the shift gate spring as necessary.

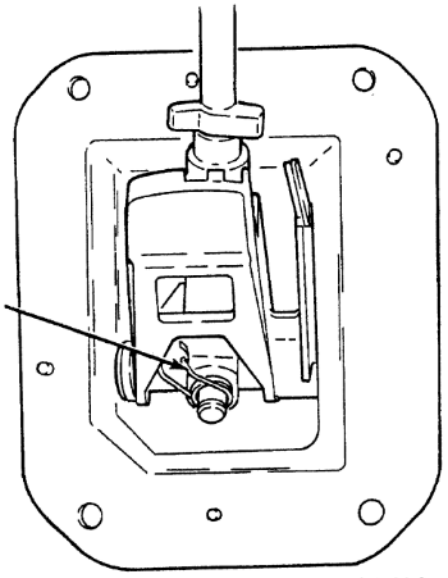
DISASSEMBLY AND ASSEMBLY

GEAR SELECTOR

Assembly (Continued)

12. Install the remaining link pin bushing.
13. Install the link pin retaining clip.
14. Using needle nose pliers, disengage the hooked end of the shift gate spring from the shift shaft link and rotate to the other side of the link. Make sure the spring hook is fully engaged on the opposite leg of the link.

    Repeat this step on the opposite side.



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15. Install the boot over the selector assembly.

    Make sure the boot is seated on the selector guide.
16. Position the shift gate housing and install the retaining clips.

SECTION 17-03 AUTOMATIC TRANSMISSION

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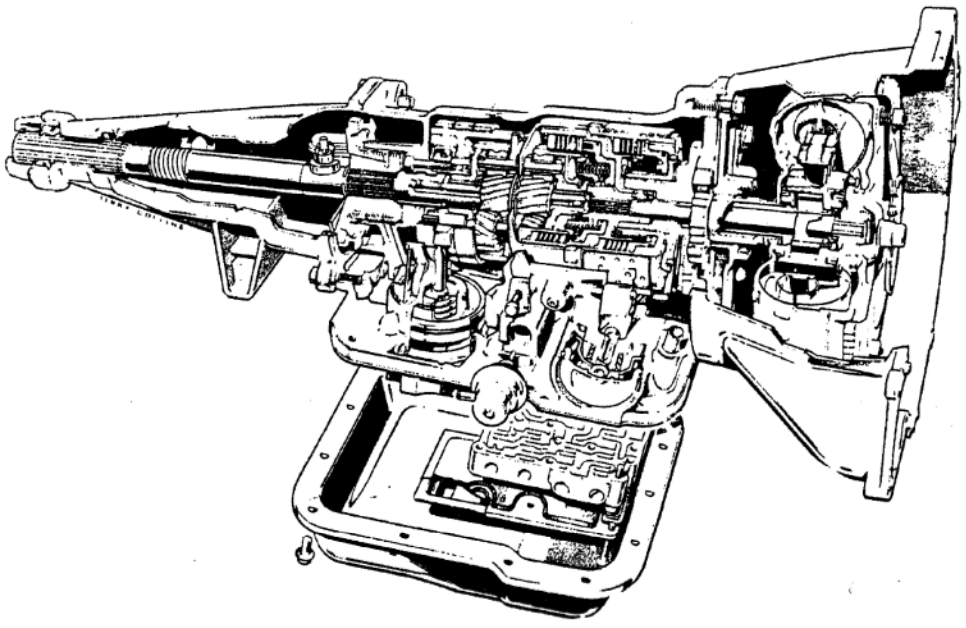
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DESCRIPTION

The C-3 Automatic Transmission is a three-speed unit capable of providing automatic upshifts and downshifts through three forward gear ratios. It also provides manual selection of first, second and reverse gears.

The transmission consists of a torque converter, planetary gear train, two multiple disc clutches, a one-way clutch and a hydraulic control system.

TRANSMISSION FLUID DRAIN AND REFILL

Normal maintenance and lubrication requirements do not necessitate periodic automatic transmission fluid changes. If major service, such as a clutch band or bearing, is required in the transmission, it will have to be removed for service. **At this time, the converter, transmission cooler, and cooler lines must be thoroughly flushed to remove any dirt.**

When used under continuous or severe conditions, the transmission and torque converter should be drained and refilled with fluid as specified. The C-3 Automatic Transmission (Code V) uses Dexron® II, or equivalent.

CAUTION: Use of a fluid other than specified above could result in transmission malfunction and/or failure.

When filling a dry transmission and converter, refer to Specifications for capacity. Check the fluid level following the room temperature checking procedures.

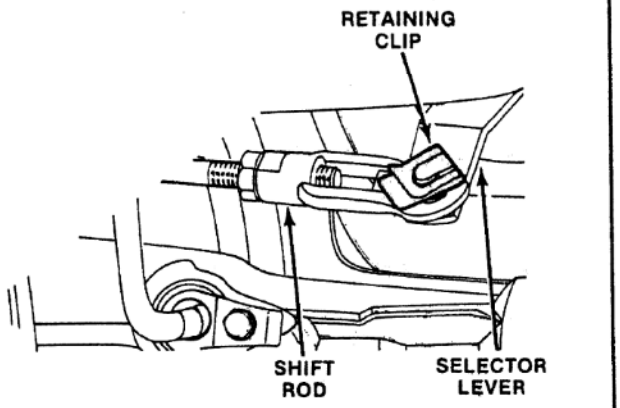
Procedures for partial drain and refill, due to in-vehicle service operation, are as follows.

1. Loosen the pan attaching bolts to drain the fluid from the transmission.
2. When all fluid has drained from the transmission, remove and thoroughly clean the pan and screen. Discard the pan gasket.
3. Place a new gasket on the pan, and install the pan on the transmission.
4. Add three quarts of fluid to the transmission through the filler tube.
5. Check the fluid level following room temperature checking procedures. If necessary, refer to Section 17-01.

ADJUSTMENTS

MANUAL LINKAGE

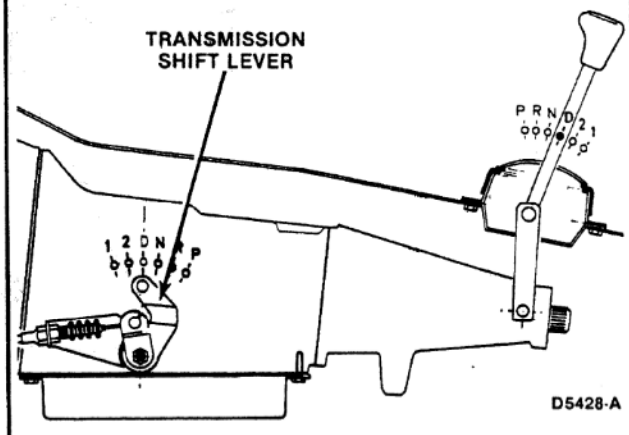
1. Raise the vehicle.
2. Remove the retaining clip and disengage the shift rod from the selector lever.



3. Rotate the transmission shift lever as far as possible toward the front of the vehicle.

   This is the Drive 1 or manual Low position.

4. Rotate the transmission shift lever two detent positions toward the rear of the vehicle.
   - This is the Drive or D position.

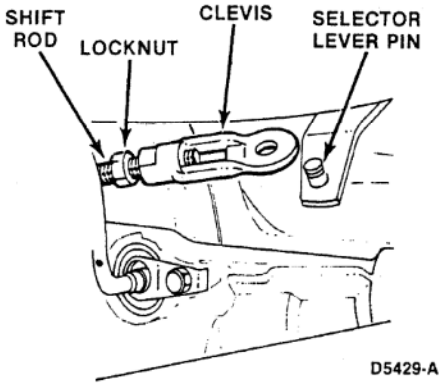


ADJUSTMENTS

MANUAL LINKAGE

Adjustment (Continued)

5. Lower vehicle.
6. Position the selector lever in the D position.
7. Raise the vehicle.
8. Without moving the transmission or selector levers, attempt to slide the shift rod clevis over the selector lever pin.
   - If the clevis slides onto the pin, the linkage is properly adjusted.
   - If the clevis does not slide onto the pin, loosen the locknut and thread the clevis in or out to obtain the proper fit.
   - After making the adjustment, tighten the clevis locknut.

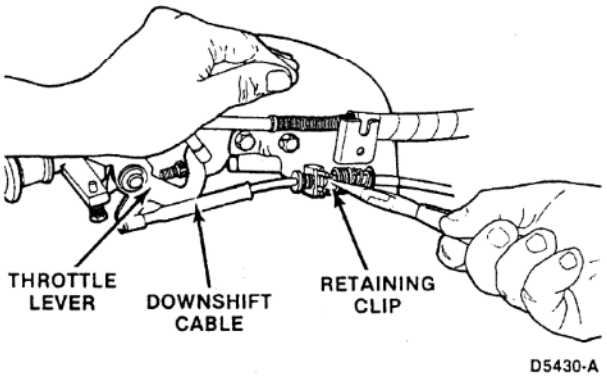


9. Install the selector rod retaining clip.
10. Lower the vehicle.

CAUTION: Make sure the linkage adjustment has not affected operation of the neutral safety switch. With the parking brake set and service brakes applied, try to start the engine in each gearshift position. The engine must crank only in the N (Neutral) and P (Park) positions. If the engine cranks in any of the other shift positions, check the linkage adjustment and neutral safety switch operation.

DOWNSHIFT CABLE

1. Using a pair of pliers, remove the cable retaining clip located near the throttle body routing bracket.



2. Rotate the throttle body lever to the wide-open position.
3. While holding the lever in the wide-open position, install the cable clip and release the lever.

FRONT BAND

SPECIAL SERVICE TOOLS REQUIRED:

Torque Wrench	T71P-77370-A

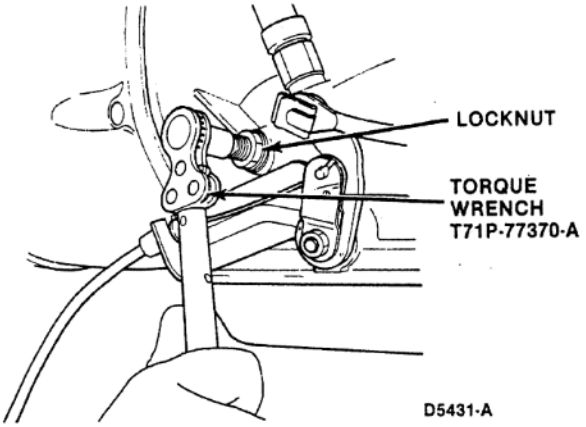
1. Clean all dirt from the band adjusting screw area. Remove and discard the locknut.

ADJUSTMENTS

FRONT BAND

Adjustment (Continued)

2. Install a new locknut on the adjusting screw. Using Torque Wrench T71P-77370-A, or equivalent, tighten the adjusting screw until tool handle clicks. The tool is a preset torque wrench that clicks when torque on the adjusting screw reaches 14 N·m (10 lb-ft).



3. Back off the adjusting screw exactly two turns.
4. Install a new locknut.
5. Hold the adjusting screw from turning and tighten the locknut to 48 to 61 N·m (35 to 45 lb-ft).

REMOVAL AND INSTALLATION

AUTOMATIC TRANSMISSION

Removal

1. Open the hood, disconnect the battery negative cable, and remove the transmission dipstick.
2. Raise the vehicle. Remove the nuts attaching the catalytic converter inlet pipe to the turbocharger.
3. Remove the attaching nuts at the catalytic converter-to-muffler inlet flange.
4. Remove the support bracket attaching bolt and then the catalytic converter and inlet pipe as an assembly.
5. Remove the driveshaft. If necessary, refer to Section 15-60.
6. Install a suitable plug in the extension housing to prevent fluid leakage.
7. Remove the starter. If necessary, refer to Section 28-02.
8. Remove the stabilizer bar U-brackets and the body stiffener rod.
9. Position a block of wood between the stabilizer bar and the body side rail.
10. Remove the torque converter to drive plate attaching nuts through the starter opening.

    To bring the nuts into position, turn the crankshaft, using a ratchet handle and socket on the crankshaft pulley attaching bolt.

CAUTION: Always turn the crankshaft clockwise which is the normal direction of rotation. Backward rotation may cause the timing belt to jump time, due to the arrangement of the belt tensioner.

11. Support the transmission with a suitable transmission jack and secure with a safety chain.
12. Remove the bolts attaching the rear mount to the transmission support bracket.
13. Remove the nuts attaching the rear mount to the body and remove the mount.
14. Lower the transmission.
15. Disconnect the speedometer cable.
16. Disconnect the wires at the neutral safety switch.
17. Disconnect the shift rod at the manual lever.
18. Disconnect the cable at the downshift lever.
19. Disconnect the vacuum hose at the vacuum modulator.
20. Disconnect the transmission cooler lines using Quick Connect Removal Tool T82L-9500-AH.
21. Remove the converter housing attaching bolts located at the top of the housing.

REMOVAL AND INSTALLATION

AUTOMATIC TRANSMISSION

Removal (Continued)

NOTE: If contact with the body prevents removal of these bolts, proceed as follows:

a. Loosen the engine mount attaching nuts until only two or three threads are visible on the end of the stud.

b. Position a block of wood against the engine oil pan and raise the front of the engine using a suitable stand.

c. Raise the engine until the stud nuts on the engine mounts contact the crossmember.

d. As the engine tilts downward, lower the transmission jack.

e. Remove the bolts.

22. Remove the remaining converter housing attaching bolts and the transmission filler tube.

23. Pull the transmission rearward and lower out of the vehicle.

Installation

1. Make sure the torque converter hub is fully engaged in the pump gear.
2. Raise the transmission into position and rotate the torque converter to align the studs with the holes in the drive plate.
3. Push the transmission forward into position against the engine.
4. Install the transmission fill tube and the converter housing attaching bolts.

   Tighten the bolts to 38 to 51 N·m (28 to 38 lb-ft).
5. Connect the transmission cooler lines.
6. Connect the vacuum hose to the vacuum modulator.
7. Connect the downshift cable.
8. Connect the shift rod.
9. Connect the neutral safety switch wires.
10. Connect the speedometer cable.
11. If it was necessary to raise the front of the engine, proceed as follows:

    a. Remove the stand and block of wood supporting the engine.

    b. Tighten the engine mount stud nuts to 68 to 95 N·m (50 to 70 lb-ft).
12. Position the rear mounts and install the attaching bolts.

    Tighten the bolt to 34 to 48 N·m (25 to 35 lb-ft).
13. Install the rear mount to transmission support bracket attaching bolts.

    Tighten the bolt to 68 to 95 N·m (50 to 70 lb-ft).
14. Remove the transmission jack.
15. Install the torque converter attaching nuts.

    Tighten the nuts to 27 to 46 N·m (12 to 16 lb-ft).
16. After removing the block of wood, install the stabilizer bar U-brackets and the body stiffener rod.

    Tighten the attaching bolts to 45 to 56 N·m (33 to 41 lb-ft).
17. Install the starter.
18. Remove the plug from the extension housing and install the driveshaft.
19. Install the catalytic converter and support bracket attaching bolt.
20. Install the flange attaching nuts at the converter outlet-to-muffler inlet connection.
21. Install the converter inlet-to-turbocharger attaching nuts.
22. Align the exhaust system and tighten the attaching nuts to 27 to 41 N·m (20 to 30 lb-ft) at the converter outlet and to 34 to 48 N·m (25 to 35 lb-ft) at the turbocharger.
23. Check and, if necessary, adjust the shift linkage and downshift cable.
24. Lower the vehicle and connect the battery.
25. Start the engine. Make sure the engine cranks only when the selector lever is positioned in the Neutral (N) or Park (P) position.

NOTE: If the transmission is empty due to an overhaul, add two quarts of fluid before starting and five more immediately after engine start-up.

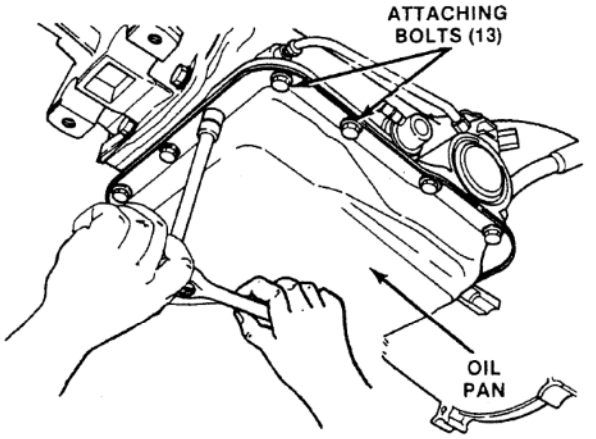
26. Check and, if necessary, adjust the transmission fluid level. Refer to Section 17 for fluid level check procedure.
27. Raise the vehicle and check for fluid leaks.

REMOVAL AND INSTALLATION

OIL PAN AND FILTER

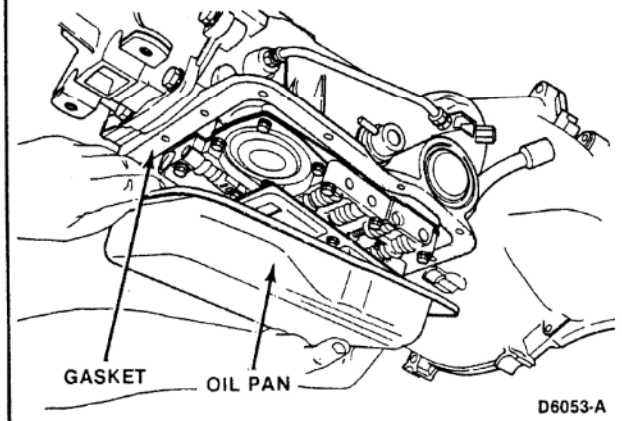
Removal

1. Raise the vehicle.
2. Place a drain pan under the oil pan. If the transmission oil is going to be reused, make sure the drain pan is absolutely clean.
3. Starting at the rear of the pan and working forward, loosen the attaching bolts and allow the transmission fluid to drain.



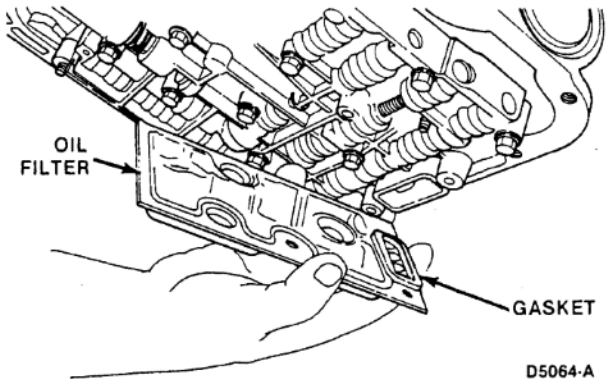
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4. Remove all of the pan attaching bolts except one in the rear and two in the front.
5. While holding the rear of the pan against the case, remove the rear attaching bolt.
6. Slowly lower the rear of the pan and allow the transmission oil to drain out of the pan.
7. Remove the front attaching bolts and the oil pan.



D6053-A

8. Remove the filter attaching screws and the filter.



D5064-A

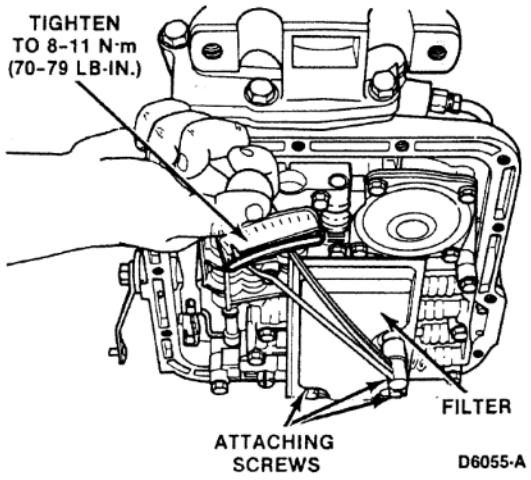
REMOVAL AND INSTALLATION

OIL PAN AND FILTER

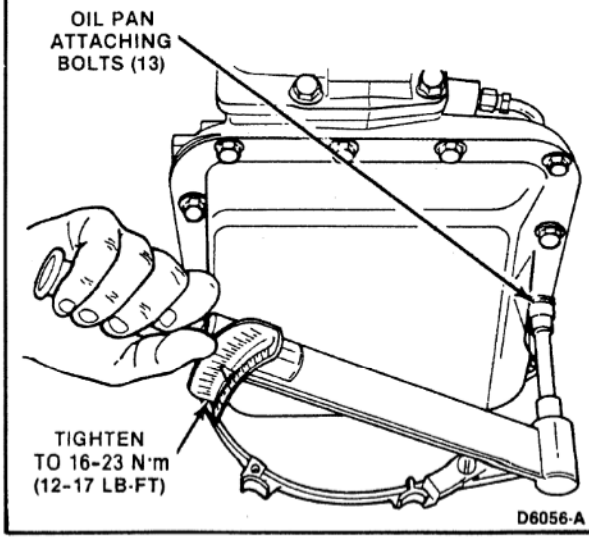
Installation

1. Clean the gasket surfaces on the oil pan and transmission case.
2. Install the oil filter gasket and the oil filter.

   Tighten the attaching screws to 8 to 11 N·m (70 to 97 lb-in.).



3. Install the oil pan using a new gasket.
4. Tighten the oil pan attaching bolts to 16 to 23 N·m (12 to 17 lb-ft).



5. Lower the vehicle.
6. Fill the transmission to the correct level, using the specified oil. If necessary, refer to the fill and fluid level check procedure in Section 17-01.

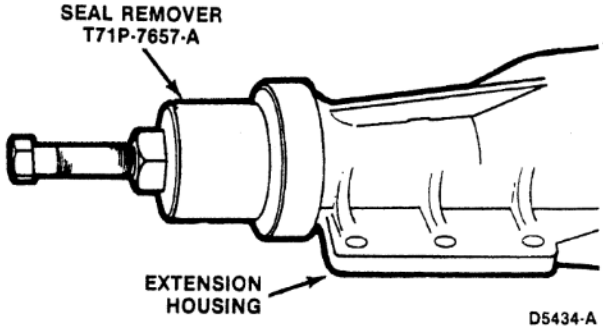
EXTENSION HOUSING OIL SEAL

SPECIAL SERVICE TOOLS REQUIRED:

Seal Remover	T71P-7657-A
Seal Replacer	T74P-77052-A

Removal

1. Remove the driveshaft. If necessary, refer to Section 15-60.
2. Remove the extension housing oil seal, using Seal Remover T71P-7657-A, or equivalent.



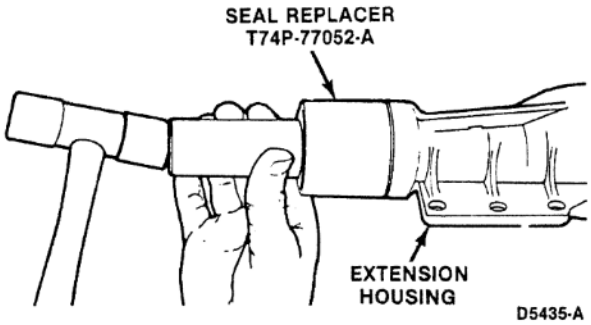
NOTE: Before installing a new seal, inspect the sealing surface on the driveshaft yoke for scoring or other roughness. If the yoke is damaged, replace the driveshaft.

REMOVAL AND INSTALLATION

EXTENSION HOUSING OIL SEAL

Installation

1. Install the extension housing oil seal, using Seal Replacer T74P-77052-A, or equivalent.



2. Install the driveshaft. If necessary, refer to Section 15-60.

EXTENSION HOUSING BUSHING

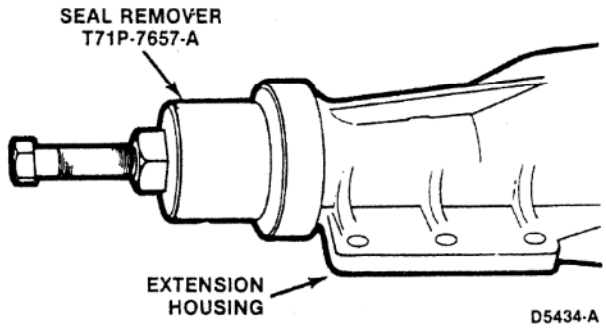
SPECIAL SERVICE TOOLS REQUIRED:

Seal Remover	T71P-7657-A
Bushing Remover	T77L-7697-E
Bushing Replacer	T77L-7697-F
Seal Replacer	T74P-77052-A

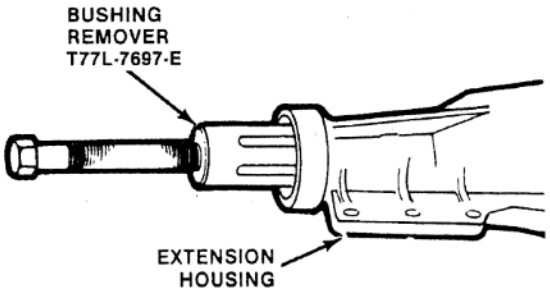
Removal

1. Remove the driveshaft. If necessary, refer to Section 15-60.

2. Remove the extension housing oil seal, using Seal Remover T71P-7657-A, or equivalent.



3. Remove the extension housing bushing, using Bushing Remover T77L-7697-E, or equivalent.



REMOVAL AND INSTALLATION

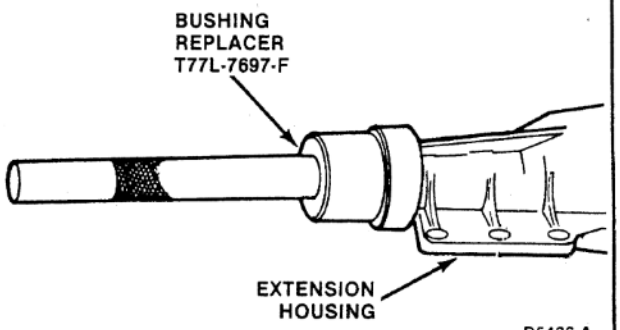
EXTENSION HOUSING BUSHING

Installation

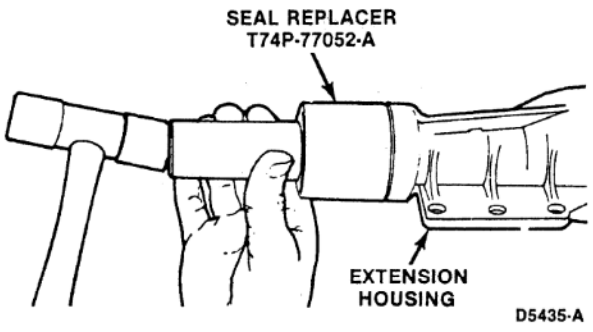
1. Inspect the bushing bore for nicks or burrs that may prevent proper seating of the bushing.

   If necessary, remove the extension housing and clean up the bore, using fine sandpaper.

2. Install the extension housing bushing, using Bushing Replacer T77L-7697-F, or equivalent.



3. Install the extension housing oil seal, using Seal Replacer T74P-77052-A, or equivalent.



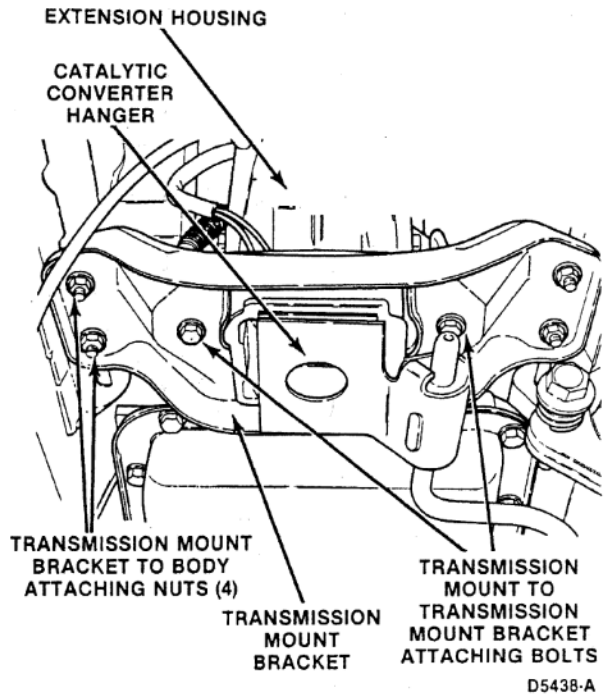
NOTE: Before installing a new seal, inspect the sealing surface on the driveshaft yoke for scoring or other roughness. If the yoke is damaged, replace the driveshaft.

4. Install the driveshaft. If necessary, refer to Section 15-60.

EXTENSION HOUSING

Removal

1. Remove the driveshaft. If necessary, refer to Section 15-60.
2. Support the transmission with a transmission jack.
3. Remove the bolts (2) attaching the transmission mount to the transmission mount bracket.

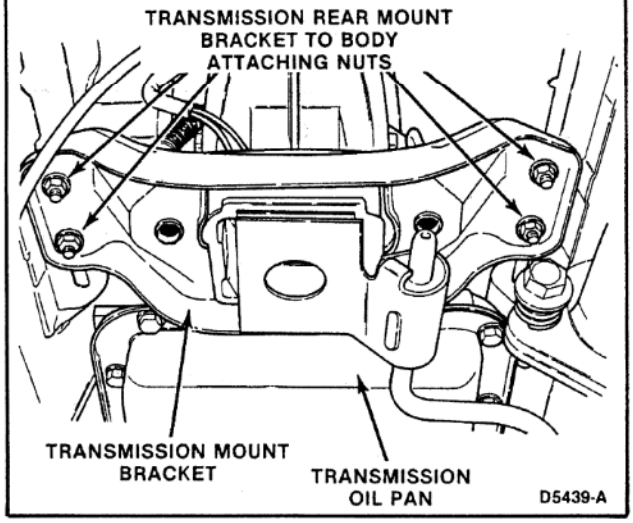


REMOVAL AND INSTALLATION

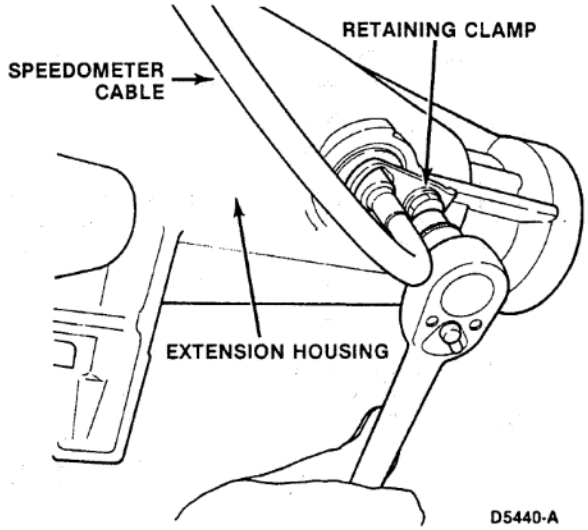
EXTENSION HOUSING

Removal (Continued)

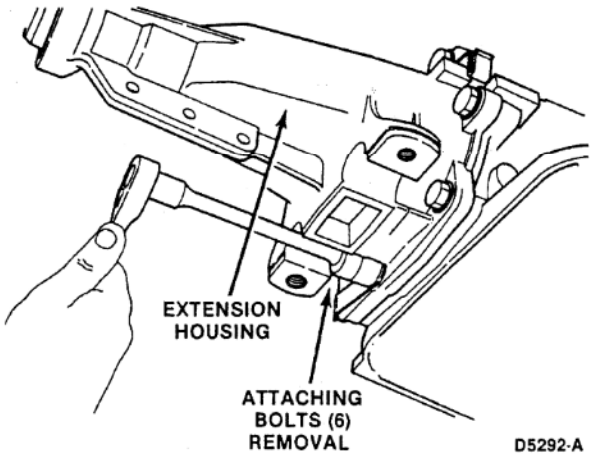
4. Remove the nuts (4) attaching the transmission mount bracket to the body and remove the transmission mount bracket and mount.



5. Remove the retaining clamp and pull the speedometer gear out of the housing.

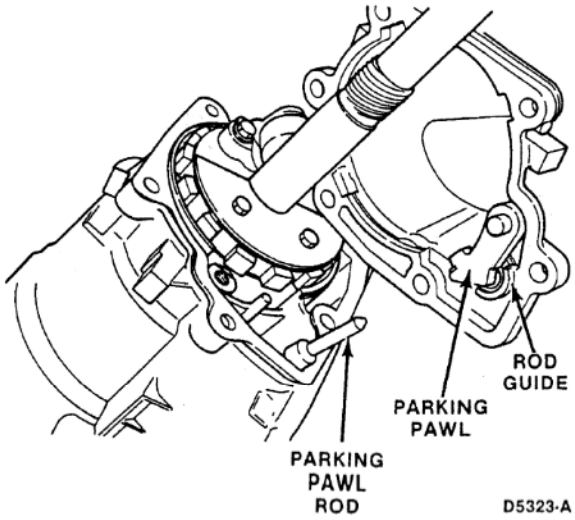


6. Position a drain pan under the extension housing.
7. Loosen the extension housing attaching bolts and allow the transmission fluid to drain.
8. Remove the attaching bolts and the extension housing.



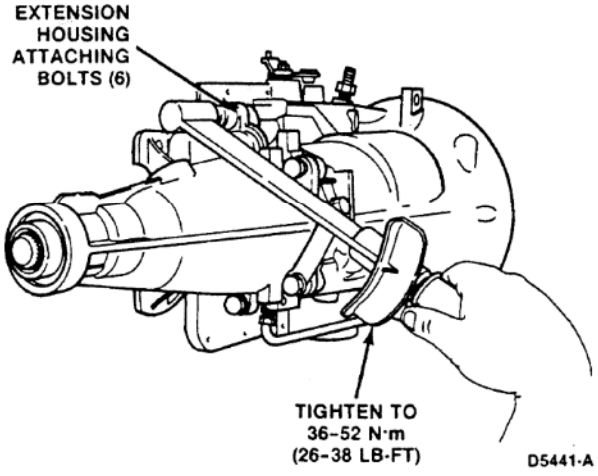
Installation

1. Position a new gasket on the extension housing.
2. Position the extension housing on the case. Make sure the parking pawl actuating rod is properly aligned before seating the housing against the case.



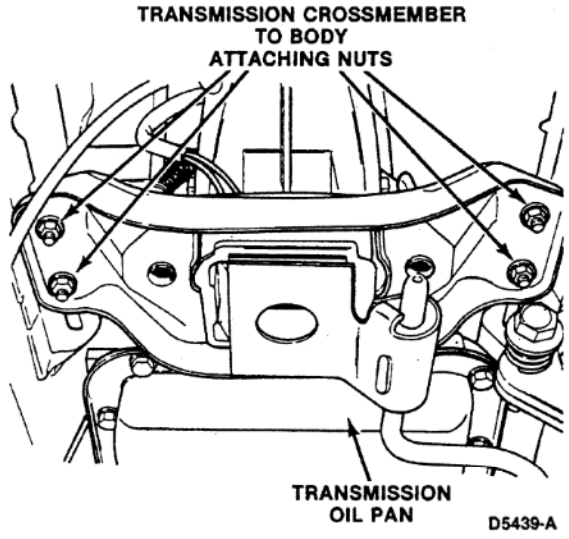
REMOVAL AND INSTALLATION (Continued)

3. Install the extension housing attaching bolts and tighten to 36 to 52 N·m (26 to 38 lb-ft).



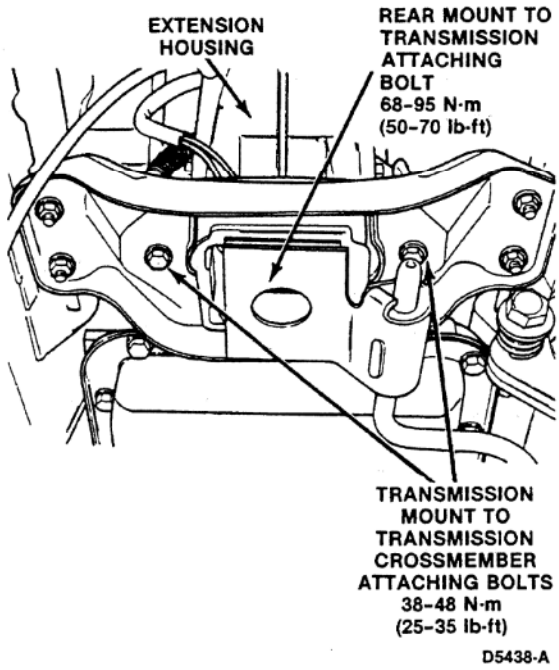
4. Position the rear mount and install the body attaching nuts.

   Tighten the bolts to 34 to 48 N·m (25 to 35 lb-ft).



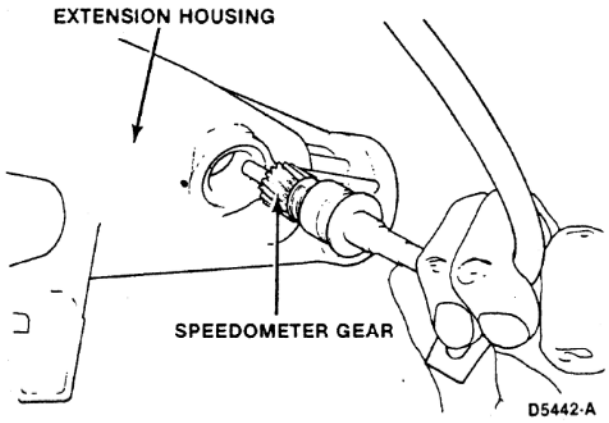
5. Install the rear mount to transmission attaching bolts.

   Tighten the bolts to 68 to 95 N·m (50 to 70 lb-ft).



6. Install the speedometer gear and the retaining clamp.

   Tighten the attaching bolts to 4 to 6 N·m (36 to 54 lb-in.).



REMOVAL AND INSTALLATION (Continued)

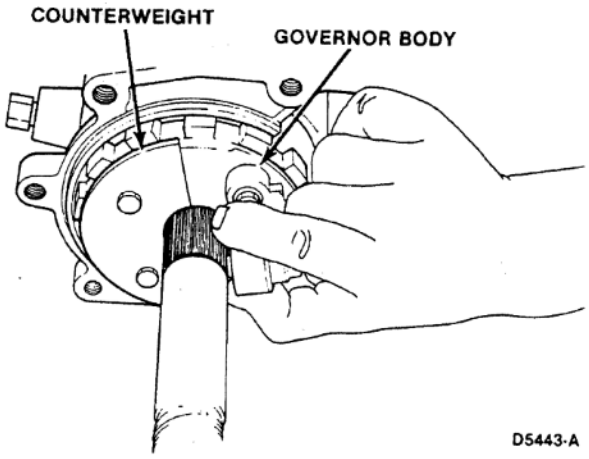
7. Remove the transmission jack.
8. Install the driveshaft. If necessary, refer to Section 15-60.
9. Fill the transmission to the correct level, using the specified oil. If necessary, refer to the fill and fluid level check procedure in Section 17-01.

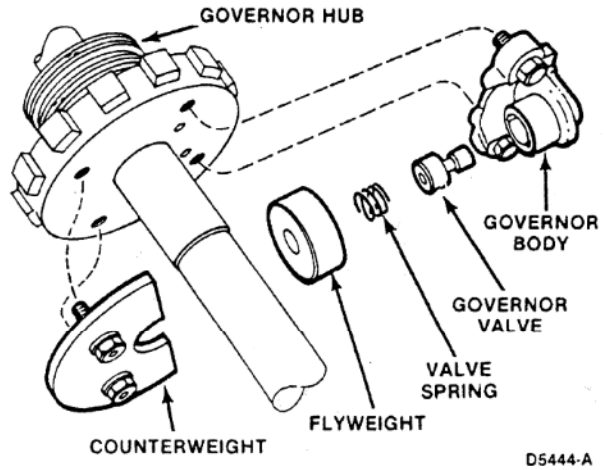
Governor

Removal

1. Remove the driveshaft. If necessary, refer to Section 15-60.
2. Remove the extension housing. If necessary, refer to the procedure in this Section.
3. Remove the governor attaching bolts and remove the governor.

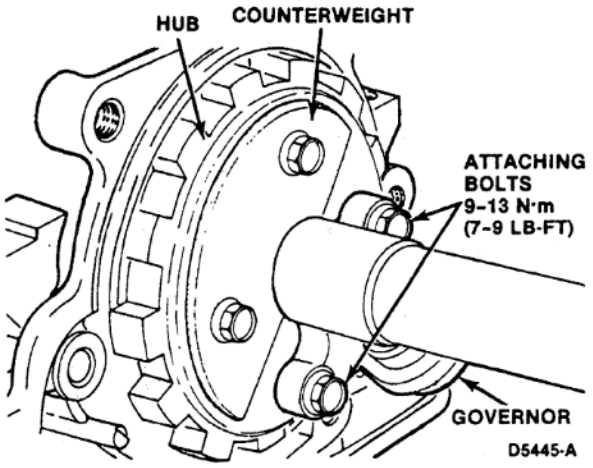
NOTE: The governor flyweight, spring, and valve are held in position by the output shaft. During removal or installation of the governor, these parts will be loose and must be held in position.





Installation

1. Turn the transmission output shaft until the bolt holes in the governor hub are at the six o'clock position.
2. Assemble the governor valve, spring, and flyweight. Make sure the valve spring is installed between the valve and flyweight.
3. Position the governor on the hub and install the attaching bolts.



REMOVAL AND INSTALLATION

GOVERNOR

Installation (Continued)

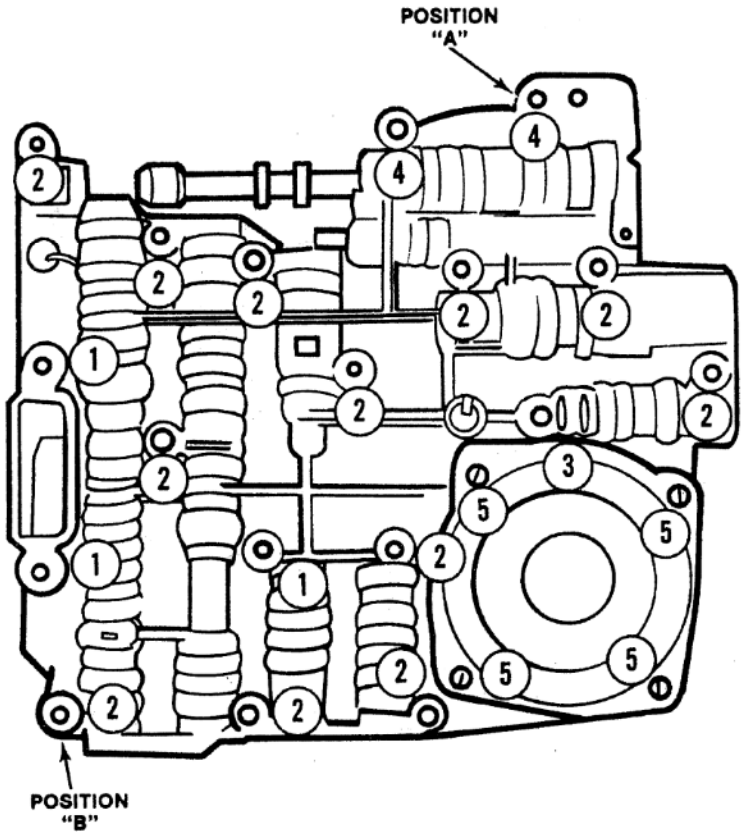
4. Install the extension housing. If necessary, refer to the procedure in this section.
5. Install the driveshaft. If necessary, refer to Section 15-60.
6. Fill the transmission to the correct level, using the specified oil. If necessary, refer to the fill and fluid level check procedure in Section 17-01.

VALVE BODY

Removal

1. Remove the oil pan and filter. If necessary, refer to the procedure in this section.

NOTE: The 22 valve body and rear servo cover attaching bolts are five different lengths. All bolt lengths have specific installed positions. Use the illustration and chart shown below to identify the location of each bolt length. As the attaching bolts are removed, they should be separated and set aside according to length.



Position	Bolt Size Metric	Length in Millimeters	Length in Inches
1	M6 x 45	45mm	1.772
2	M6 x 40	40mm	1.578
3	M6 x 35	35mm	1.378
4	M6 x 30	30 mm	1.18
5	M6 x 20	20mm	.787

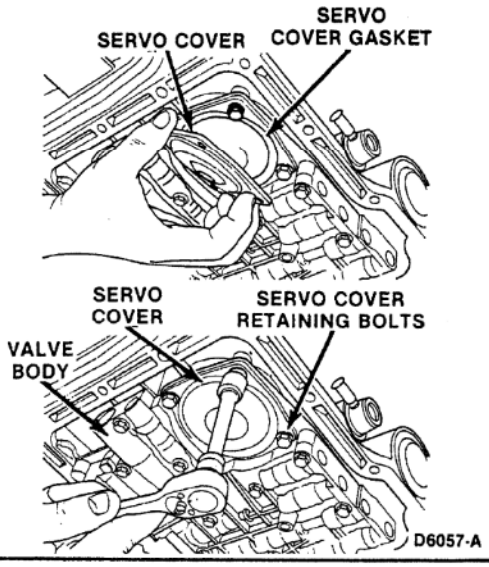
Position	Quantity	Torque N·m	Torque Lb-Ft
1	3	8-11	6-8
2	12	8-11	6-8
3	1	8-11	6-8
4	2	8-11	6-8
5	4	9.5-13.5	7-10

REMOVAL AND INSTALLATION

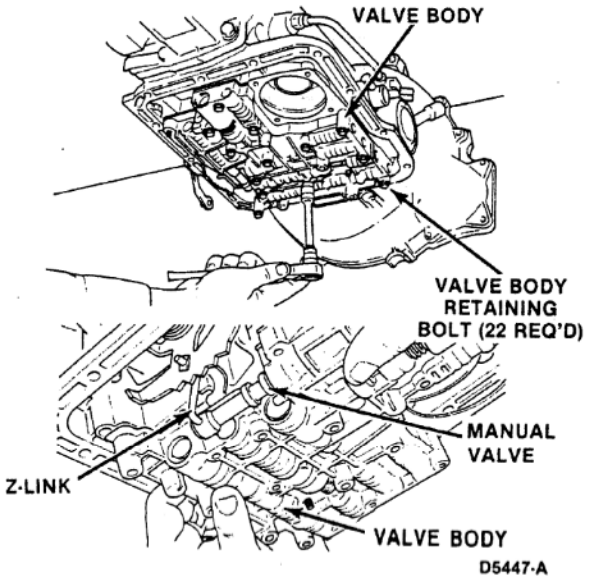
VALVE BODY

Removal (Continued)

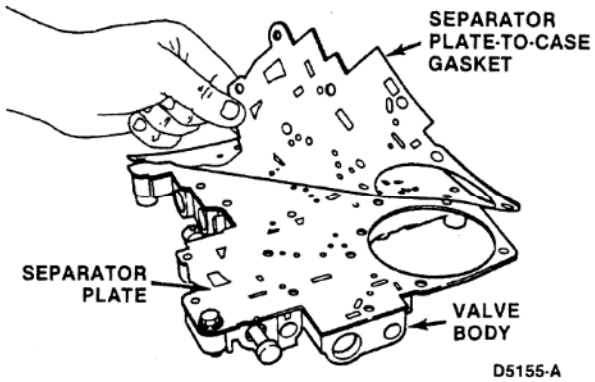
2. Remove the rear servo cover and gasket.



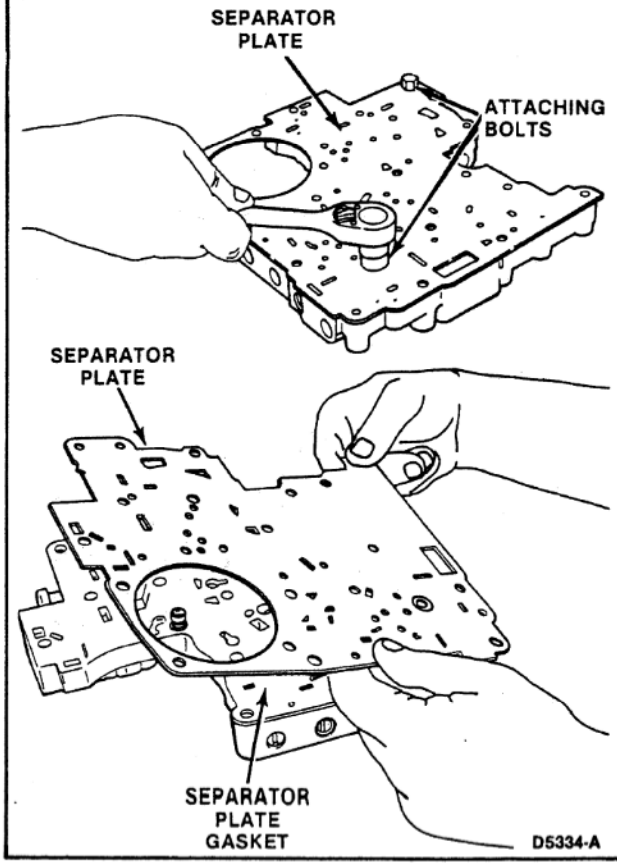
3. Remove the valve body attaching bolts and lower the valve body out of the transmission. As the valve body is lowered, disconnect the selector lever Z-link from the manual valve.



4. Remove and discard the separator plate-to-case gasket.



5. Remove the separator plate attaching bolts, the separator plate and the separator plate gasket. Discard the gasket.



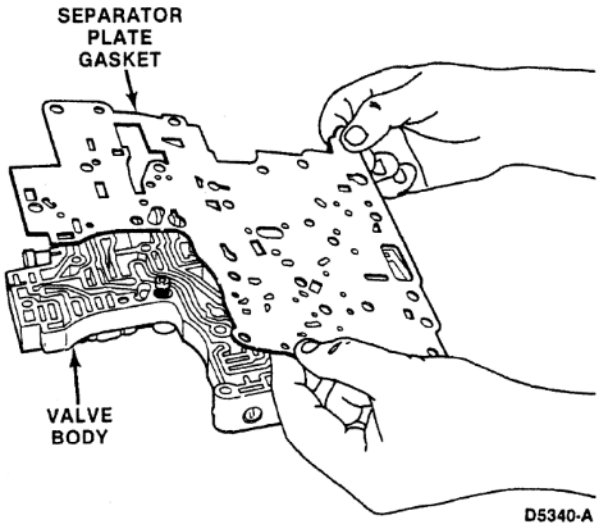
REMOVAL AND INSTALLATION

VALVE BODY

Installation

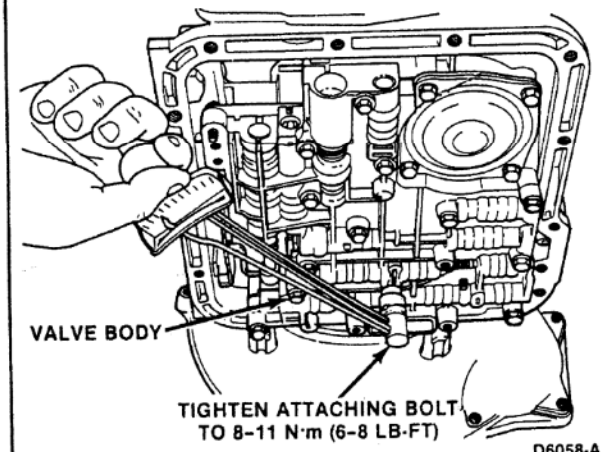
1. Position the separator plate and a new gasket on the valve body. Install a M6 × 35 mm valve body attaching bolt at positions "A" and "B" to align the separator plate with the valve body (see chart after step one for location of "A" and "B").

   Install the separator plate attaching bolts (M6 × 25) and tighten to 10 to 12 N·m (84 to 107 lb-in.). Remove the alignment bolts.

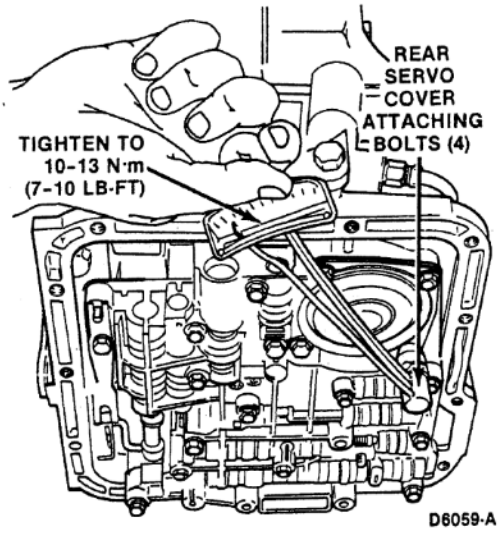


2. Have a 40 mm (1.578 in.) and 30 mm (1.141 in.) bolt ready to install when the valve body is positioned in the transmission.
3. Connect the Z-link to the manual valve and position the valve body in the transmission.
4. Loosely install the 30 mm (1.18 in.) attaching bolt at position A and the 40.1 mm (1.578 in.) attaching bolt at position B (see chart following Step 1 of removal).
5. Install the remaining attaching bolts.

   Make sure each bolt length is installed in the correct position.
6. Position the rear servo cover with a new gasket and install the attaching bolts.
7. Tighten the valve body attaching bolts to 8 to 11 N·m (6 to 8 lb-ft).



8. Tighten the rear servo cover attaching bolts to 10 to 14 N·m (7 to 10 lb-ft).



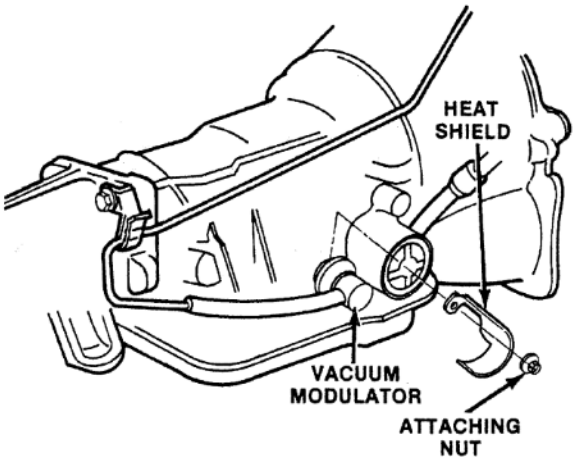
9. Install the filter and oil pan.
10. Fill the transmission to the correct level using the specified oil. If necessary, refer to the fill and fluid level check procedure in Section 17-01.

REMOVAL AND INSTALLATION

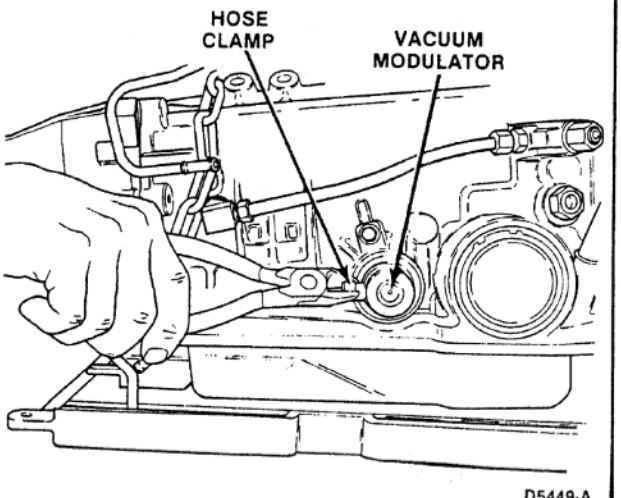
VACUUM MODULATOR

Removal

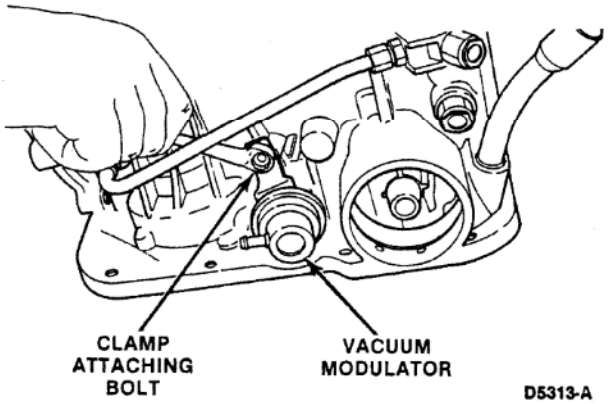
1. Remove the attaching nut and the vacuum modulator heat shield.



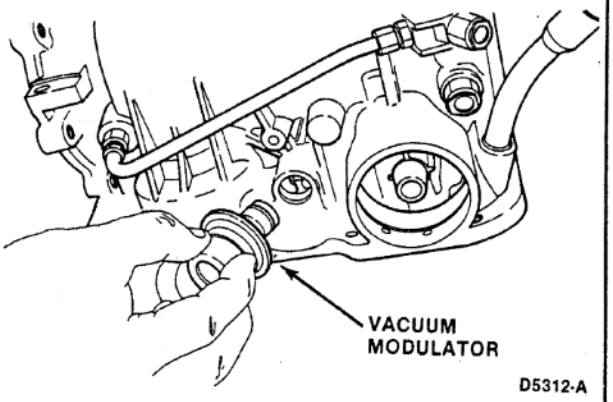
2. Disconnect the vacuum hose from the vacuum modulator fitting by cutting the hose clamp.



3. Remove modulator retaining bolt and the modulator retaining clamp.



4. Pull the vacuum modulator out of the case.



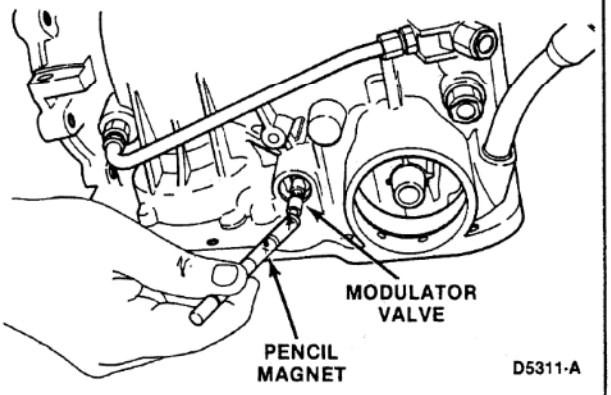
5. Remove the actuating pin and O-ring from the modulator. Discard the O-ring.

REMOVAL AND INSTALLATION

VACUUM MODULATOR

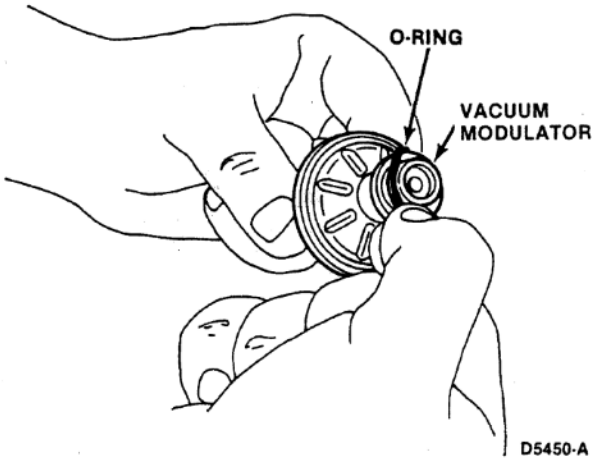
Removal (Continued)

6. If necessary, the modulator valve can be removed from the case bore using a pencil magnet.

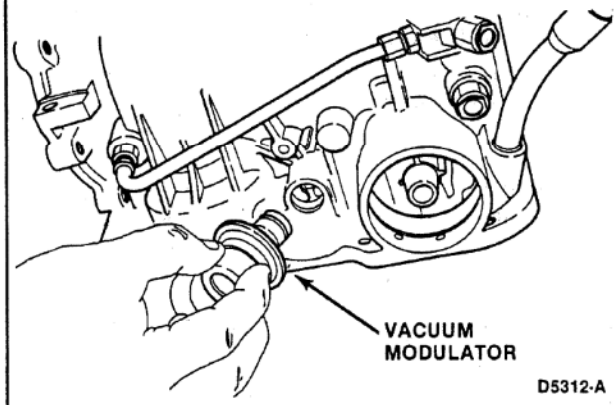


Installation

1. If removed, install the throttle valve.
2. Install a new O-ring on the vacuum modulator.



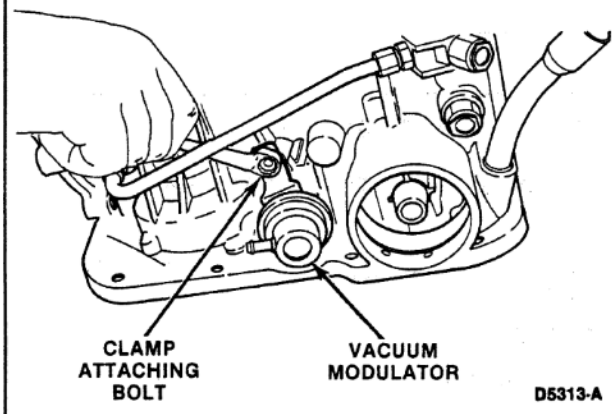
3. Install the actuating pin in the vacuum modulator.
4. Install the vacuum modulator in the case.



Make sure the vacuum fitting faces the rear of the case.

5. Position the retaining clamp and install the attaching bolt.

   Tighten the attaching bolt to 9 to 12 N·m (7 to 9 lb-ft).



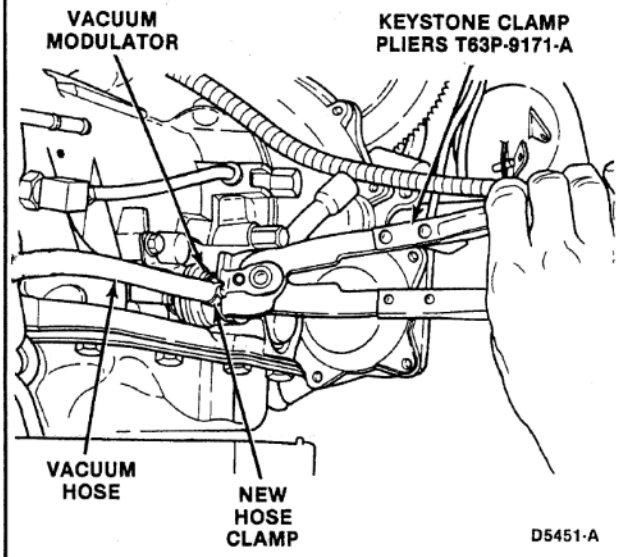
6. Position the vacuum modulator heat shield and install the attaching nut. Make sure the shield is not contacting the modulator. Position it to provide a 4mm (1/8″) clearance.

REMOVAL AND INSTALLATION

VACUUM MODULATOR

Installation (Continued)

7. Position a new keystone clamp over the vacuum modulator hose and connect the hose to the modulator.
8. Tighten the hose clamp using Keystone Clamp Pliers T62P-9171-A, or equivalent.



NEUTRAL SAFETY SWITCH

SPECIAL SERVICE TOOLS REQUIRED:

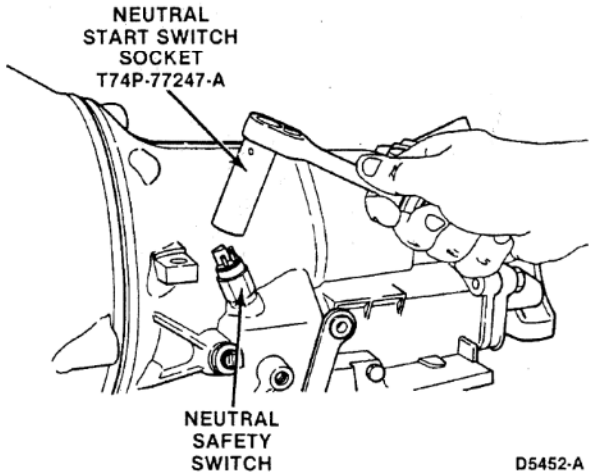
Neutral Safety Switch Socket T74P-77247-A

Removal

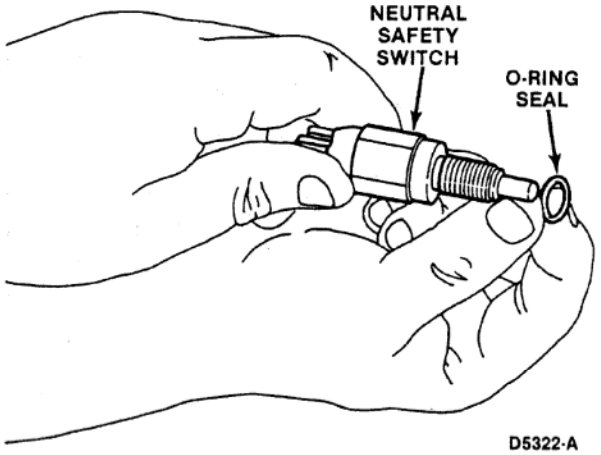
1. Disconnect the wiring from the switch.

2. Remove the switch, using Socket T74P-77247-A.

   Do not use an open-end wrench. The twisting force of the wrench will collapse the switch housing.



3. Remove and discard the switch O-ring.

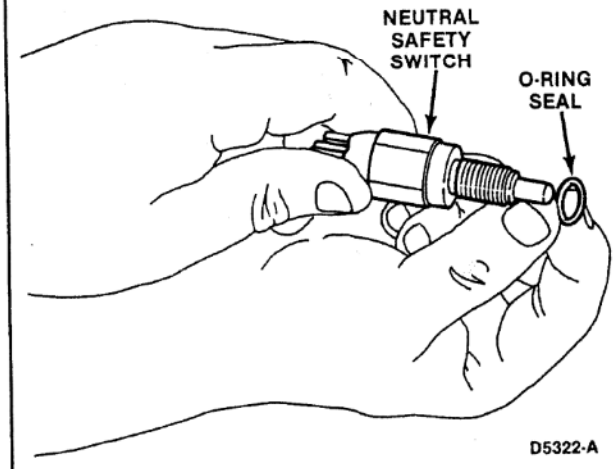


REMOVAL AND INSTALLATION

NEUTRAL SAFETY SWITCH

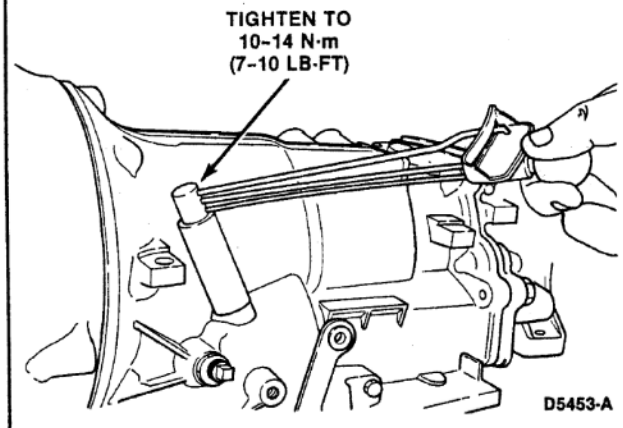
Installation

1. Install a new O-ring on the switch.



2. Install the switch.

   Tighten the switch to 10 to 14 N·m (7 to 10 lb-ft).



3. Connect the wiring to the switch.

CAUTION: Make sure the switch operates properly. With the parking brake set and service brakes applied, try to start the engine in each gearshift position. The engine must crank only in the N (Neutral) and P (Park) positions. If the engine cranks in any of the other gearshift positions, check the gearshift linkage adjustment (Section 17-02). If the linkage is properly adjusted, check the switch and switch circuit for a problem.

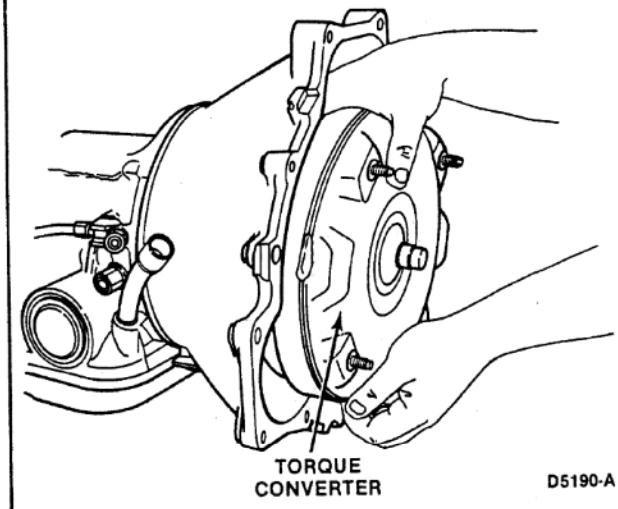
PUMP SEAL

SPECIAL SERVICE TOOLS REQUIRED:

Seal Remover	T74P-77248-A
Slide Hammer	T50T-100-A
Seal Replacer	T74P-77248-B

Removal

1. Remove the transmission. If necessary, refer to the procedure in this section.
2. Remove the torque converter.

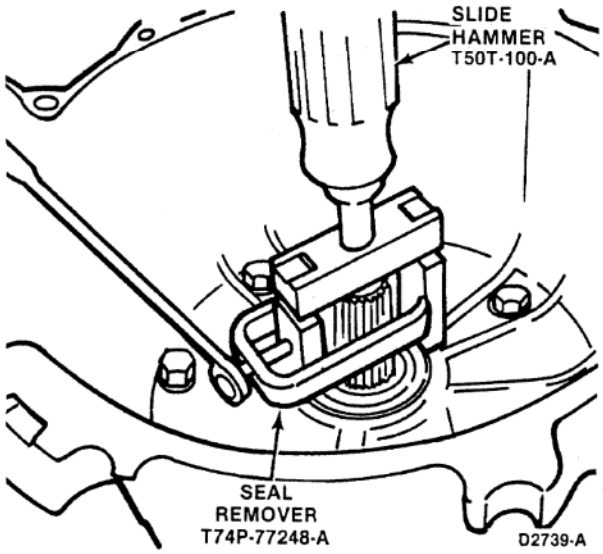


REMOVAL AND INSTALLATION

PUMP SEAL

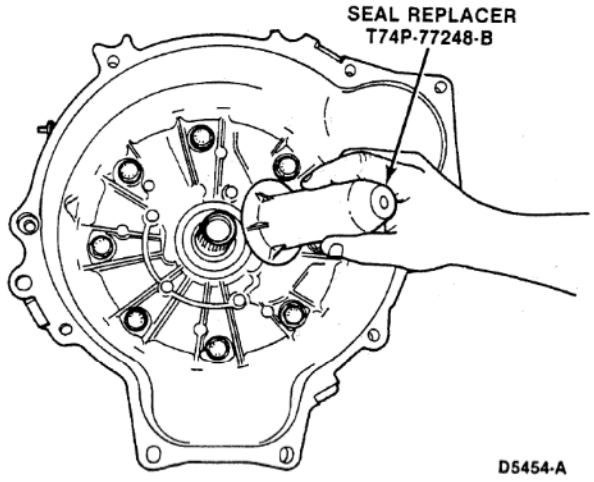
Removal (Continued)

3. Remove the pump seal, using Seal Remover T74P-77248-A and Slide Hammer T50T-100-A, or equivalents.

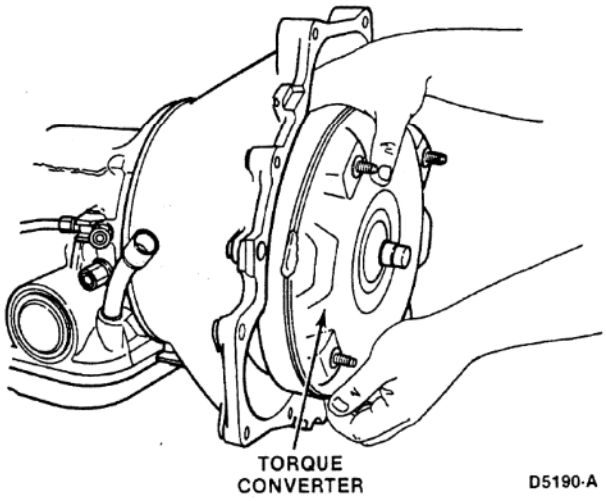


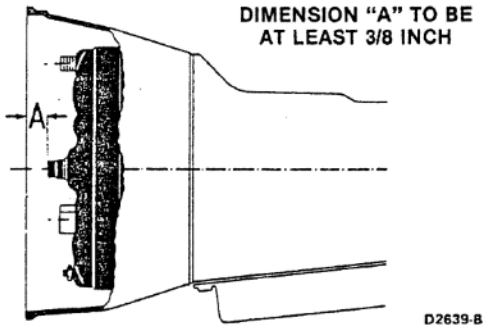
Installation

1. Install the pump seal, using Seal Replacer T74P-77248-B, or equivalent.



2. Install the torque converter. Make sure the converter hub is fully engaged in the pump gear. The dimension shown in the illustration is for guidance only. It does not indicate engagement.





3. Install the transmission. If necessary, refer to the procedure in this section.

SHIFT LEVER OIL SEAL

SPECIAL SERVICE TOOLS REQUIRED:

Seal Replacer	T74P-77498-A

Removal

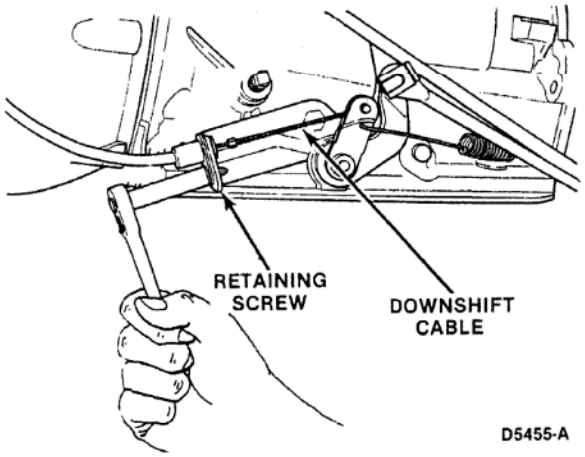
1. Remove the transmission oil pan. If necessary, refer to the procedure in this section.

REMOVAL AND INSTALLATION

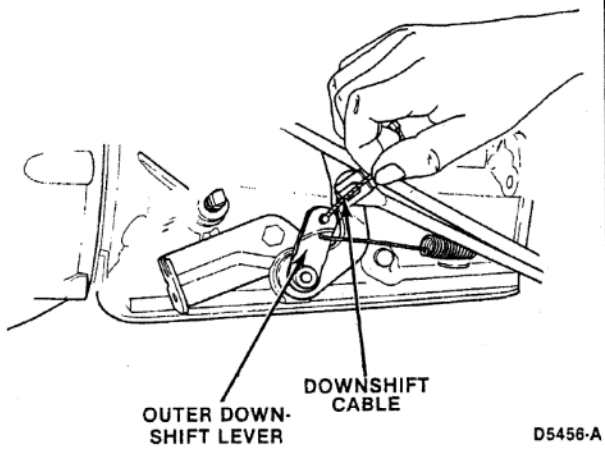
SHIFT LEVER OIL SEAL

Removal (Continued)

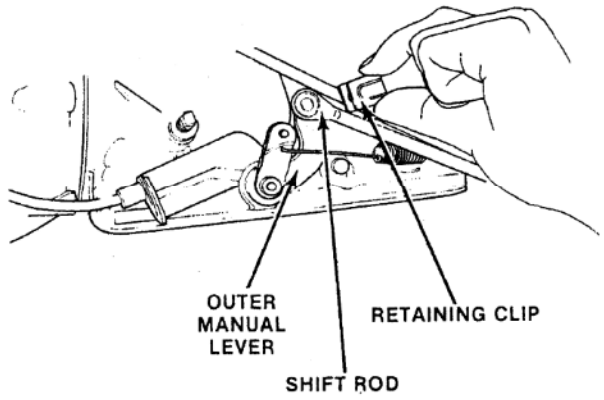
2. Remove the downshift cable retaining screw.



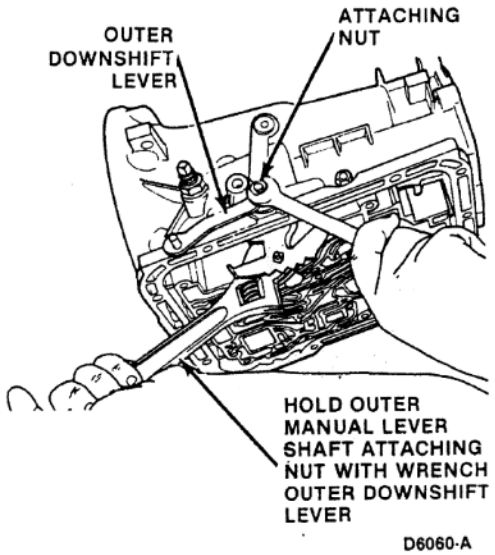
3. Disconnect the downshift cable from the outer downshift lever.



4. Remove the retaining clip and disconnect the shift rod from the outer manual lever.



5. Hold the outer manual lever shaft attaching nut with a wrench and remove the attaching nut and the outer downshift lever.



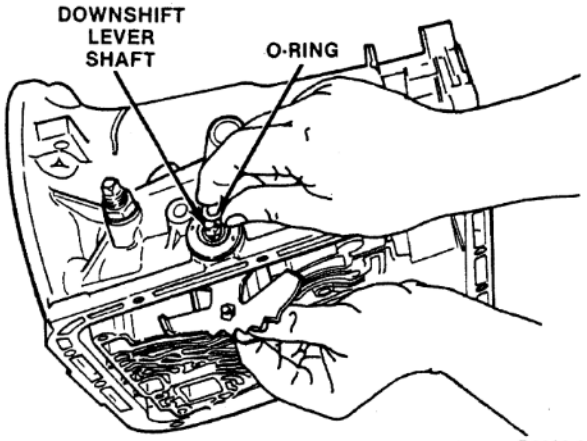
REMOVAL AND INSTALLATION

SHIFT LEVER OIL SEAL

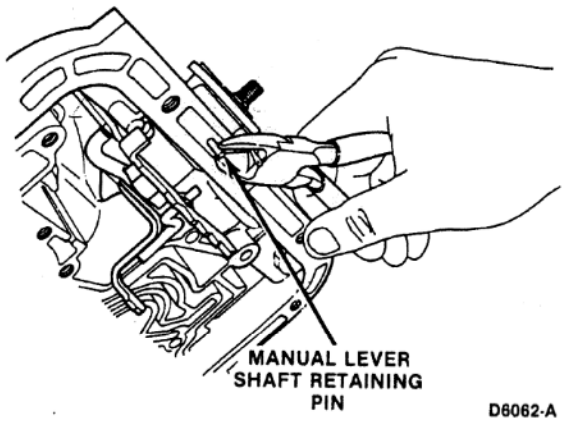
Removal (Continued)

6. Remove the O-ring from the downshift lever shaft.

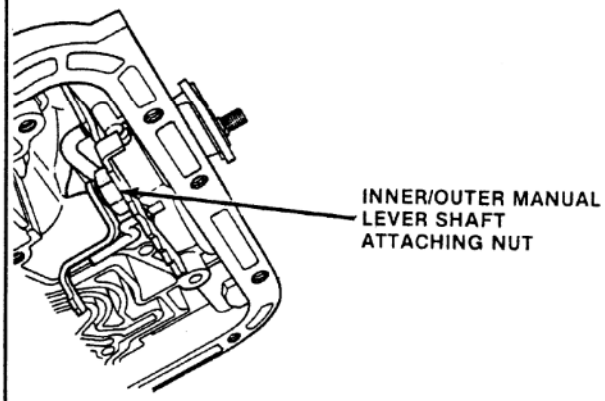
   Discard the O-ring.



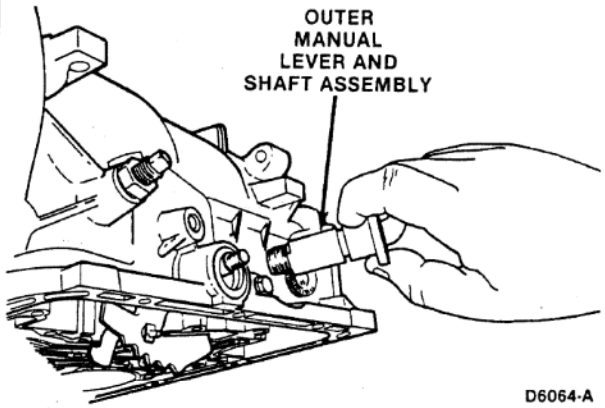
7. Remove the manual lever shaft retaining pin from the case.



8. Remove the attaching nut from the outer manual lever shaft.



9. Carefully pull the outer manual lever and shaft assembly out of the case.

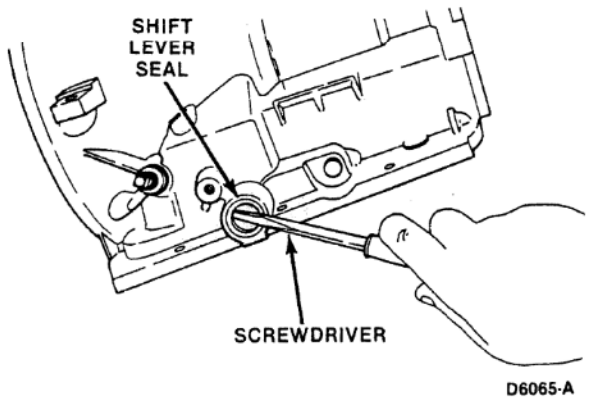


REMOVAL AND INSTALLATION

SHIFT LEVER OIL SEAL

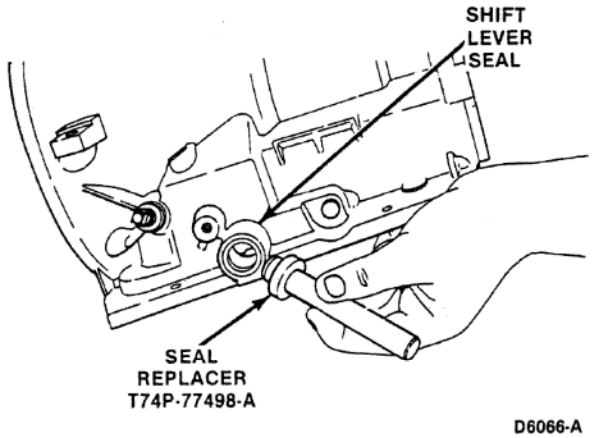
Removal (Continued)

10. Remove the shift lever oil seal from the case, using a screwdriver.



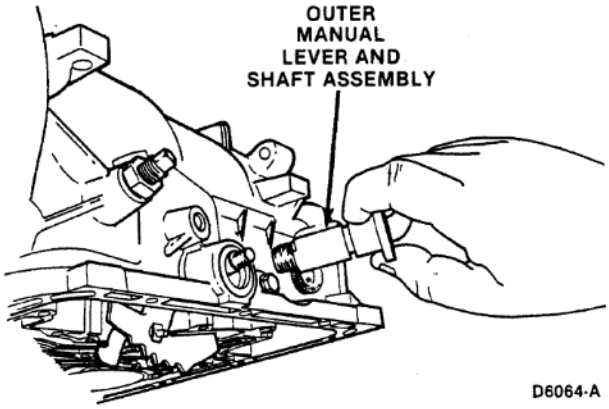
Installation

1. Install a new seal in the case, using Seal Replacer T74P-77498-A, or equivalent.

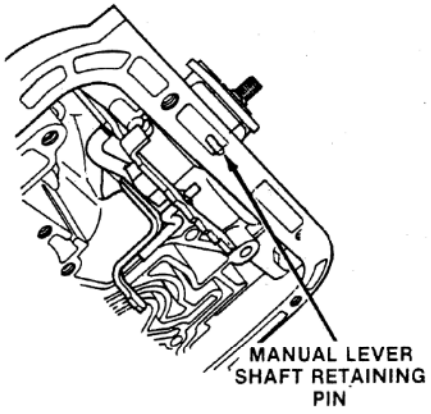


2. Carefully slide the manual lever shaft into the case.

   As the shaft enters the case, position the throttle lever return spring, inner manual lever, and attaching nut on the shaft.



3. Install the manual lever shaft retaining pin in the case.

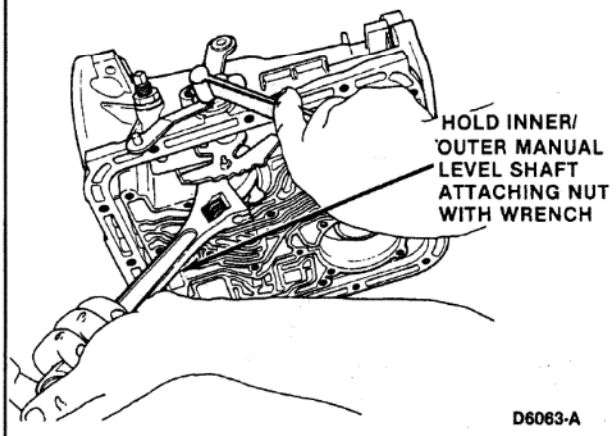


REMOVAL AND INSTALLATION

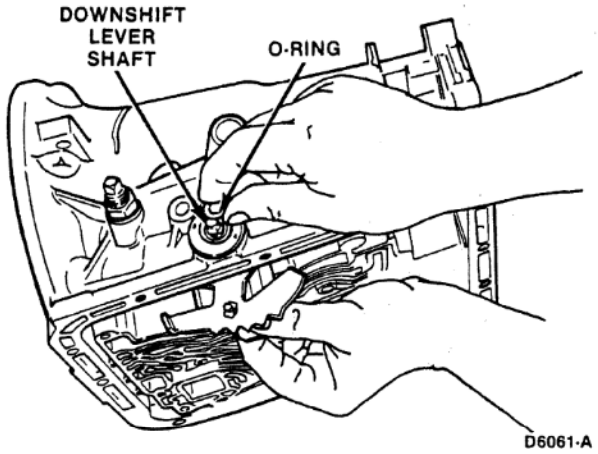
SHIFT LEVER OIL SEAL

Installation (Continued)

4. Securely tighten the inner/outer manual lever attaching nut.

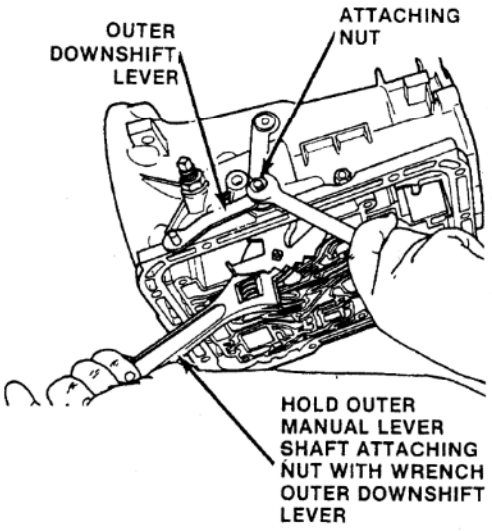


5. Install a new O-ring on the downshift lever shaft.



6. Install the outer downshift lever.

   Tighten the attaching nut to 10 to 14 N·m (7 to 11 lb-ft).



7. Connect the shift rod to the outer manual lever and install the retaining clip.
8. Connect the downshift cable to the outer downshift lever and install the retaining screw.
9. Install the oil pan. If necessary, refer to the procedure in this section.
10. Check and, if necessary, adjust the shift linkage and downshift cable. If necessary, refer to Section 17-02.
11. Fill the transmission to the correct level, using the specified oil. If necessary, refer to the fill and fluid level check procedure in Section 17-01.

DISASSEMBLY AND ASSEMBLY

TRANSMISSION

Disassembly

SPECIAL SERVICE TOOLS REQUIRED:

Front Servo Compressor	T74P-77028-A
One-Way Clutch Replacing Guide	T74P-77193-A
Servo Rod Selecting Gauge	T74P-77190-A
Dial Indicator	TOOL-4201-C
Pump Aligner	T74P-77103-X

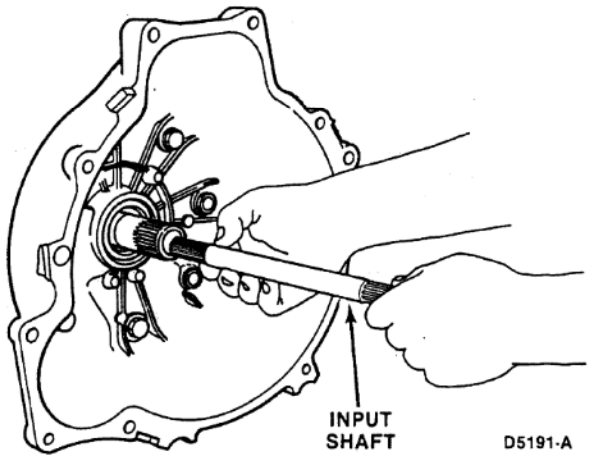
NOTE: Before beginning the transmission overhaul, review the following guidelines. These general rules are provided to emphasize the need for attention to detail and care when servicing an automatic transmission.

- Thorough cleaning of the transmission exterior will reduce the possibility that damaging contaminants might enter the subassemblies during disassembly and assembly.
- All fasteners must be tightened to the torque indicated in the text. In addition to appearing in the text, the necessary torques can also be found in the specifications section at the end of this group.
- When building up subassemblies, each component part should be lubricated with clean transmission fluid. It is also good practice to lubricate the subassemblies as they are installed in the case.
- Needle bearings, thrust washers and seals should be lightly coated with petroleum jelly during subassembly buildup or transmission assembly.
- Many components and surfaces in the transmission are precision machined. Careful handling during disassembly, cleaning, inspection, and assembly can prevent unnecessary damage to machined surfaces.
- When building up subassemblies or assembling the transmission, always use new gaskets and seals.
- The transmission service area should be kept clean, well organized and supplied with clean lint-free shop cloths.

- Whenever a seal is removed from a piston, shaft, or servo, note the type of seal and when applicable, the direction of the sealing lip.
- Always use the specified transmission oil when lubricating seals or other components prior to assembly (refer to Specifications for the proper oil).
- Fluid used with the C-3 automatic transmission contains a detergent which retains in suspension particles generated during normal transmission use. This characteristic may result in a dark coloration of the fluid and does not by itself indicate malfunction or need for service.

1. Grasp the torque converter firmly and pull straight out of the transmission.

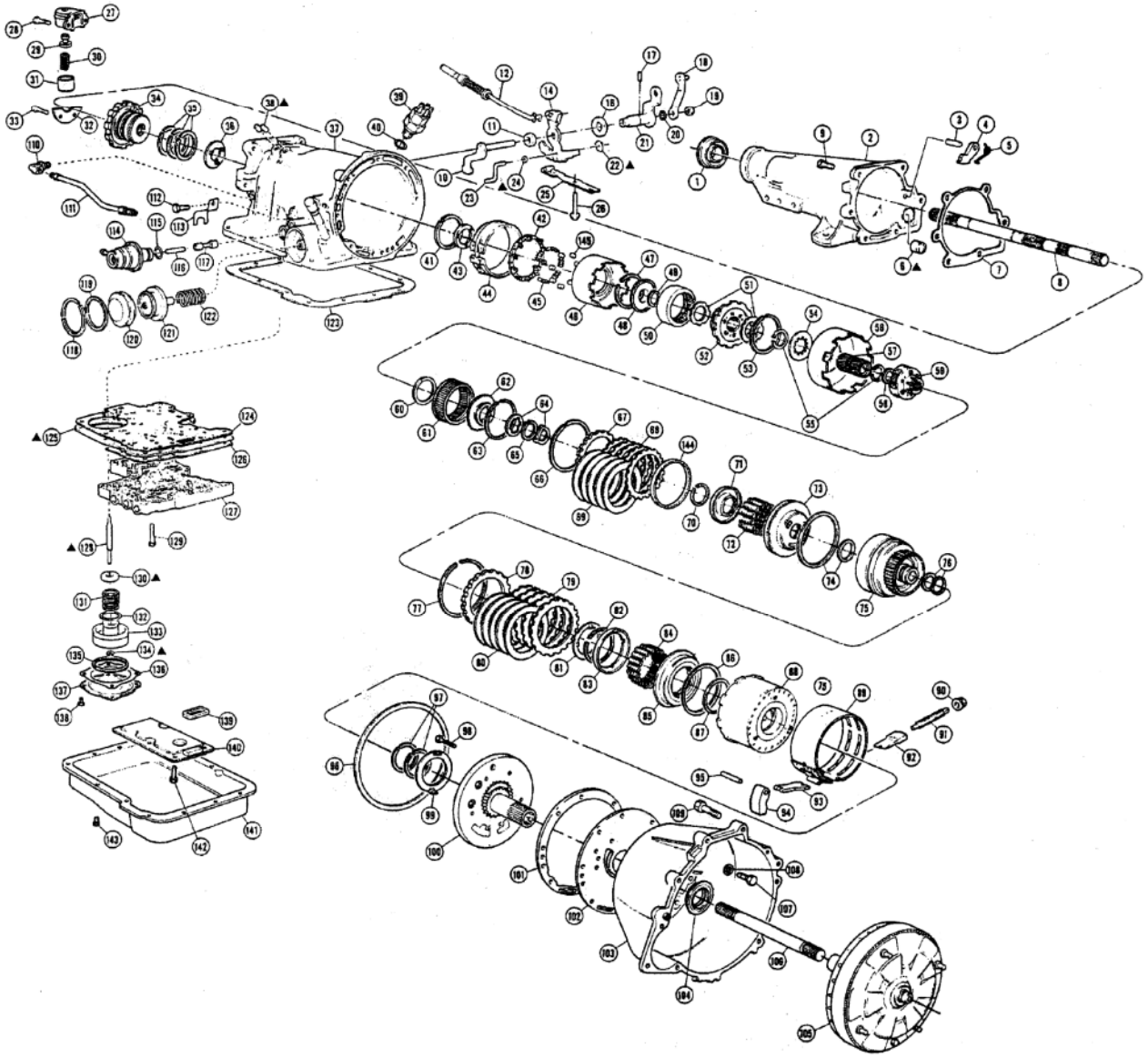
2. Remove the input shaft.



3. Remove the oil pan and gasket.

DISASSEMBLY AND ASSEMBLY

TRANSMISSION DISASSEMBLED VIEW



DISASSEMBLY AND ASSEMBLY

LEGEND FOR TRANSMISSION DISASSEMBLED VIEW

1.	7052	SEAL ASSY (EXT. HSG.) — OIL
2.	7A039	HOUSING (EXTN.)
3.	7D071	SHAFT (PARKING PAWL)
4.	7A441	PAWL (PARKING)
5.	7D070	SPRING (PARKING PAWL RETURN)
▲6.	7D419	CUP — PARKING ROD GUIDE
7.	7086	GASKET (EXTN. HSG.)
8.	7060	SHAFT ASSY (OUTPUT)
9.	E800152-S72	SCREW — M10 X 30 (EXTENSION TO CASE)
10.	7D261	LEVER ASSY (DOWNSHIFT DETENT INNER)
11.	E820112-S	NUT (LVR. TO LVR. ASSY. DOWNSHIFT DET. IN.)
12.	7D410	ROD ASSY. (PARKING PAWL ACTUATING)
13.		
14.	7C494	LEVER (MAN. CONTROL INNER)
15.		
16.	7B498	SEAL ASSY. — MANUAL CONTROL LVR. OIL
17.	E840125-S	PIN — GROOVE ROLLER (RET. OUTER MAN. LVR. ASSY.)
18.	7A394	LEVER ASSY. (DOWNSHIFT & CONT. OUTER)
19.	E820109-S72	NUT — HEX M8 X 1 (OUTER MAN. LVR. TO SHAFT)
20.	386078-S	O'RING (TRANS. DOWNSHIFT SHAFT)
21.	7A256	LEVER ASSY. (MANUAL CONTROL)
▲22.	E662312-S	CLIP — ROD RETAINING
23.	7E333	PIN — MAN. VALVE DET. — INNER
▲24.	E630020-S	WASHER — FLAT STEEL
25.	7E332	SPRING ASSY. (MAN. VALVE DET.)
26.	E800185-S	SCREW — M6 X 30 (VALVE BODY TO CASE) 2 REQ'D.
27.	7A300	BODY — GOV. VALVE
28.	E800156-S	BOLT — M6 X 20 (GOV. BODY TO COLLECTOR BODY) 2 REQ'D.
29.	7C054	VALVE (GOVERNOR PRIMARY)
30.	7A302	SPRING (GOVERNOR VALVE)
31.	7D324	WEIGHT (GOVERNOR OUTER)
32.	7F124	COUNTERWEIGHT — GOVERNOR
33.	E602164-S72	BOLT (GOV. BODY TO COLLECTOR BODY) 2 REQ'D.
34.	7D220	BODY (GOV. OIL COLLECTOR)
35.	7D011	RING (GOV. HSG. SEAL) 3 REQ'D.
36.	7B368	WASHER (OUTPUT SHAFT THRUST GR.)
37.	E840115-S	CASE ASSY. — TRANS.
▲38.	E840115-S	PIN — REV. BAND ANCHOR (2 REQ'D.)
39.	7A247	SWITCH ASSY. — NEUT. GR. SHIFT
40.	E853116-S	SEAL (NEUTRAL SWITCH TO CASE)
41.	E860120-S	RING (RETAINER)
42.	7D191	RETAINER (OVR. RUN CLUTCH W. SPG.)
43.	7D422	WASHER — (O.P. SHAFT HUB THRUST)
44.	7D095	BAND ASSY. (REV)
45.	7D170	SPRING — OVR. RUN CLUTCH
46.	7C498	DRUM ASSY. (REV. BRAKE)
47.	E661125-S	RETAINING RING 25 X 1.2
48.	7D164	HUB (OUTPUT SHAFT) — 57 EXT. — 31 INT. TEETH
49.	E860122-S	RING (RETAIN HUB)
50.	7A153	GEAR (OUTPUT SHAFT RING)
51.	7D423	WASHER (PLANET CARR. THRUST) 2 REQ'D.
52.	7D006	PLANET ASSY. (REV)
53.	E860119-S	RING (PLANET TO DRUM)
54.	7D066	WASHER (INPUT SHELL THRUST)
55.	E860121-S	RING (GOV. TO SHELL) 39MM 2 REQ'D.
56.	7D064	SHELL (INPUT)
57.	7D063	GEAR ASSY. — SUN
58.	7D235	BRG. THRUST — SUN GEAR RACE — RR
59.	7A398	PLANET ASSY. (FWD)
60.	7F374	BRG. ASSY. — CL. INT. DRUM THRUST
61.	7D392	GEAR (RING FWD) 72 EXT. 57 INT. TEETH
62.	7D393	HUB (FWD RING GEAR)
63.	E860122-S	RET. RING — 87 MM
64.	7D090	WASHER (FWD. CYL. HUB THRUST) 3 TABS
65.	E661138-S	RING (RETAIN HUB) 38 X 1.75MM
66.	E860115-S	RET. RING (SELECT FIT)
67.	7B066	PLATE (FWD. CLUTCH PRESS.)
68.	7B442	PLATE (CLUTCH) — FORWARD
69.	7B164	PLATE ASSY. — CLUTCH (FWD)
70.	E860109-S	RING (HUB TO GEAR)
71.	7D041	RET (FWD. CL. PISTON SPRING)
72.	7C151	SPRING (CLUTCH PISTON) 15 REQ'D.
73.	7A262	PISTON ASSY. (FWD. CLUTCH)
74.	7A548	SEAL (CLUTCH PISTON OIL)
75.	7D424	CYL. ASSY. (FWD. CLUTCH)
76.	7D019	SEAL (FWD. CLUTCH CYL.) 2 REQ'D.
77.	E860126-S	RET. RING (SELECT FIT)
78.	7B066	PLATE (CLUTCH PRESS) REV.
79.	7B442	PLATE (CLUTCH) HIGH
80.	7B164	PLATE ASSY. (CLUTCH) HIGH
81.	7D428	WASHER (INTM. BRAKE DRUM THRUST)
82.	E860125-S	RET. RING 83 MM
83.	7D041	RET. (CLUTCH PISTON SPRING) — 8 TABS
84.	7C151	SPRING (REV. CLUTCH PISTON) 20 REQ'D.
85.	7A258	PISTON (REV. CLUTCH)
86.	7A548	SEAL (CLUTCH PISTON OIL)
87.	7D404	SEAL (HIGH CLUTCH PISTON INNER)
88.	7D044	DRUM ASSY. (INTERM. BRAKE)
89.	7D034	BAND ASSY. (INTERM. SERVO)
90.	388307-S100	NUT & SEAL — HEX
91.	7C492	SCREW (REVERSE BAND ADJ.)
92.	7D430	STRUT — (INTERM. BRK. BAND ANCHOR)
93.	7D029	STRUT — (INTERM. BRK. BAND APPLY)
94.	7D396	LEVER (INTERM. BAND SERVO)
95.	7D433	SHAFT (INTERM. BAND ACT. LEVER)
96.	7D441	SEAL ASSY. (FRT. OIL PUMP)
97.	7D429	SEAL RINGS (STATOR SUPPORT)
98.	E800163-S	BOLT — (PUMP ASSY. TO CONV. HSG.) 5 REQ'D.
99.	7D014	WASHER (FRT. PUMP SUPPORT THRUST) SEL. FIT
100.	7L201	SUPPORT & GEAR ASSY. (FRT. PUMP)
101.	7A136	GASKET (OIL PUMP)
102.	7B472	PLATE (OIL PUMP ADAPTER)
103.	7975	HSG. ASSY. (CONV.)
104.	7A248	SEAL ASSY. (FRT. OIL PUMP)
105.	7902	CONVERTER ASSY.
106.	7017	SHAFT (INPUT)
107.	E800152-S72	SCREW (SUPT. & GEAR ASSY. TO CASE) 8 REQ'D.
108.	E830124-S	WASHER FLAT (SUPT. & GEAR ASSY. TO CASE) 8 REQ'D.
109.	N800054-S51	SCREW (CONV. HSG. TO ENGINE) 6 REQ'D.
110.	7D273	CONNECTOR ASSY. (OIL TUBE)
111.	7A254	TUBE ASSY. (OIL COOLER BY-PASS)
112.	E800341-S72	SCREW (VALVE CLAMP TO CASE)
113.	7E458	CLAMP (THRT. VALVE CONT. DIAPH.)
114.	7A377	DIAPH. ASSY. (THROTTLE VALVE CONT.)
115.	E853110-S	O'RING — DIAPH. ASSY.
116.	7A380	ROD (THROTTLE CONT. VALVE)
117.	7D080	VALVE (THROTTLE CONTROL)
118.	E860343-S	RETAINER (COVER TO CASE)
119.	7A114	SEAL (SERVO COVER TO CASE)
120.	7D027	COVER (INTERM. BAND SERVO)
121.	7E221	PISTON & ROD ASSY. (INTERM. BAND SERVO)
122.	7D028	SPRING (INTERM. BAND SERVO PISTON)
123.	7A191	GASKET (OIL PAN)
124.	7D100	GASKET (VALVE BODY SEP. PLATE)
▲125.	7A008	PLATE (MAIN CONTROL SEP.)
126.	7D100	GASKET (VALVE BODY SEP. PLATE UPPER)
127.	7A100	CONTROL ASSY. (MAIN)
▲128.	7D190	ROD (REVERSE BAND SERVO PISTON)
129.	E800153-S	SCREW (VALVE BODY TO CASE)
▲130.	E830130-S	RET. — REV. SERVO CUSHION SPRING
131.	7E207	SPRING (REVERSE BAND ACCUM.)
132.	7423	OIL SEAL — REV. BAND SERVO PST. — SMALL
133.	7D030	PISTON & ROD ASSY. (REV. BAND SERVO)
▲134.	E860167-S	RING RETAINER (RET. ROD TO PISTON)
135.	7423	OIL SEAL — REV. BAND SERVO PST. — LARGE
136.	7L173	GASKET — REV. SERVO SEP. PLT. CVR.
137.	7D036	COVER (REV. BAND SERVO)
138.	E800156-S	SCREW (COVER TO VALVE BODY) 4 REQ'D.
139.	7E062	GASKET — TRANS. OIL PAN SCREEN
140.	7A098	SCREEN ASSY. (OIL PAN)
141.	7A264	OIL PAN
142.	E800154-S	SCREW (VALVE BODY TO CASE) 3 REQ'D.
143.	E800158-S72	SCREW (PAN TO CASE) 13 REQ'D.
144.	7E457	SPRING — FORWARD CLUTCH CUSHION
145.	7190	ROLLER — OVERRUN CLUTCH

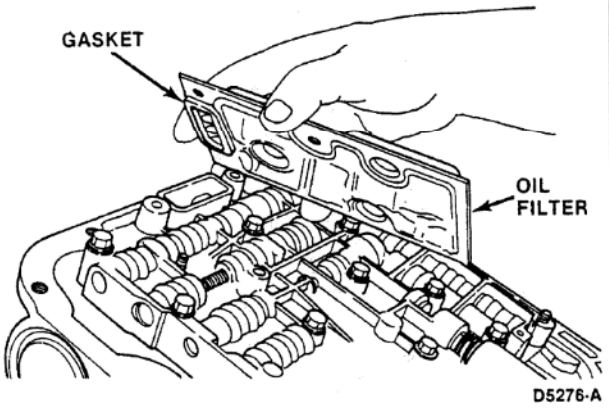
▲ NOT SERVICED

DISASSEMBLY AND ASSEMBLY

TRANSMISSION

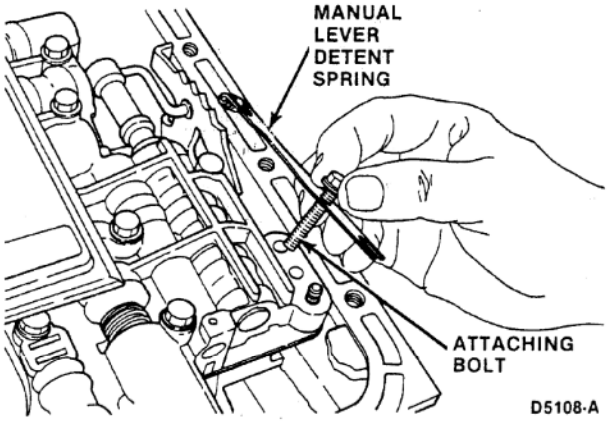
Disassembly (Continued)

4. Remove the oil filter and gasket.

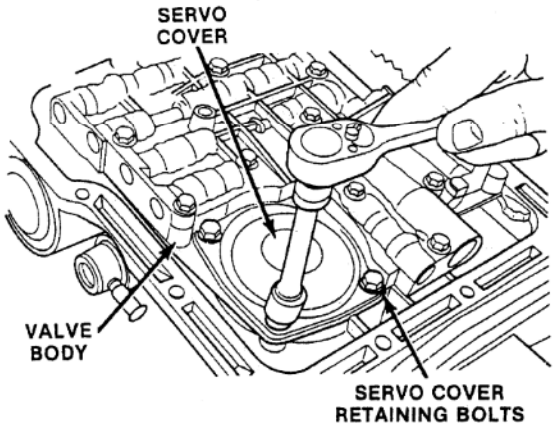


NOTE: Between the detent spring, oil filter, rear servo cover, and valve body, five different attaching bolt lengths will be encountered. As each component is removed, set it aside with its attaching bolts. The various bolt lengths and their positions are shown on page 13.

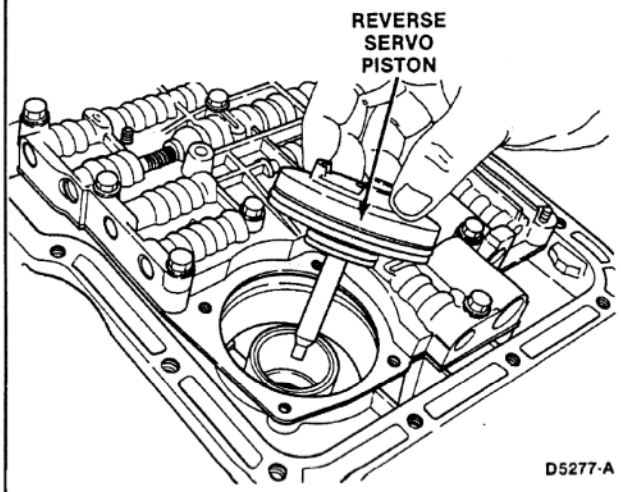
5. Remove the manual lever detent spring attaching bolt and the detent spring.



6. Remove the reverse servo cover and gasket.



7. Remove the reverse servo piston.

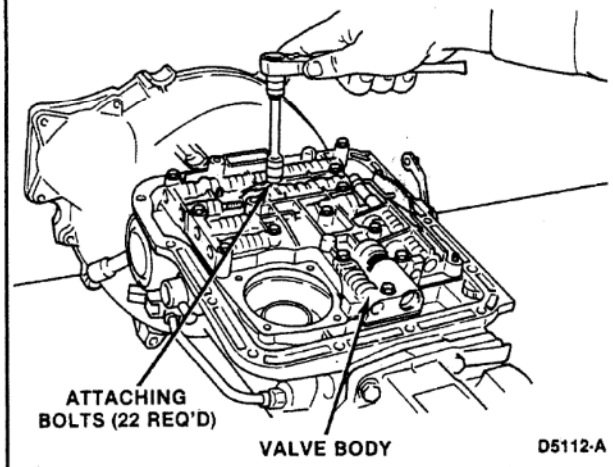


DISASSEMBLY AND ASSEMBLY

TRANSMISSION

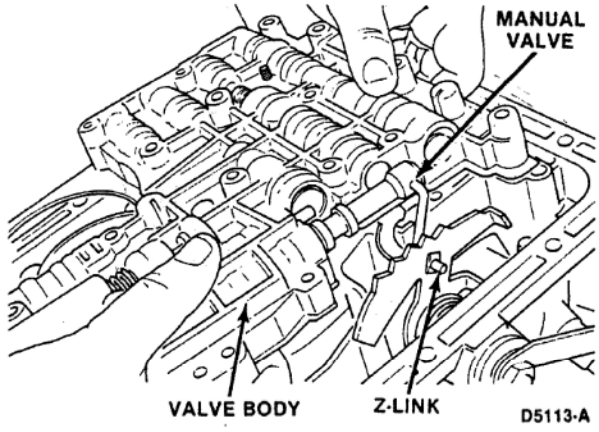
Disassembly (Continued)

8. Remove the valve body attaching bolts.

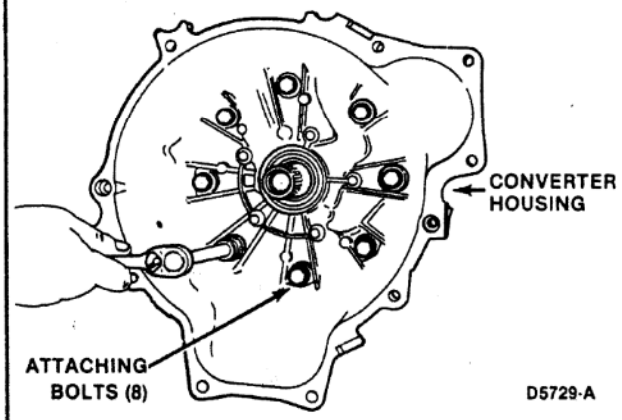


9. Remove the valve body.

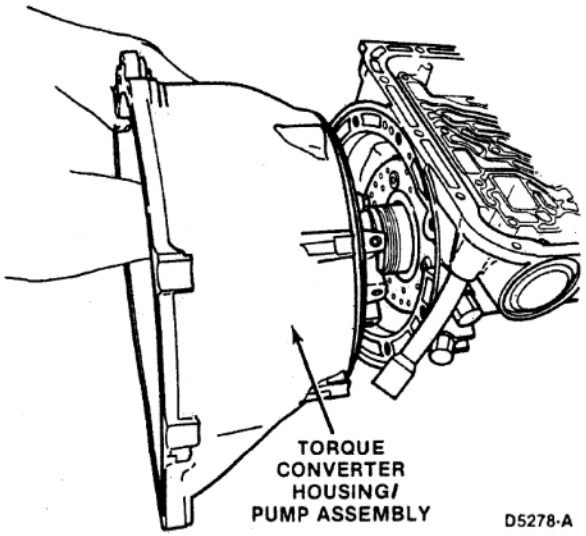
   As the valve body is raised, disconnect the selector lever Z-link from the manual valve.



10. Remove the converter housing attaching bolts.



11. Remove the converter housing and pump assembly.

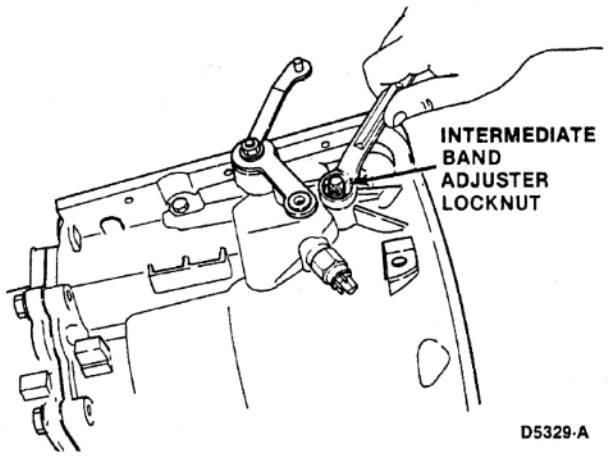


DISASSEMBLY AND ASSEMBLY

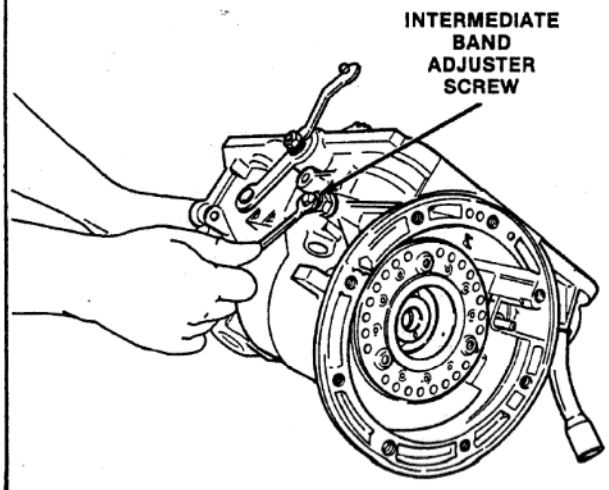
TRANSMISSION

Disassembly (Continued)

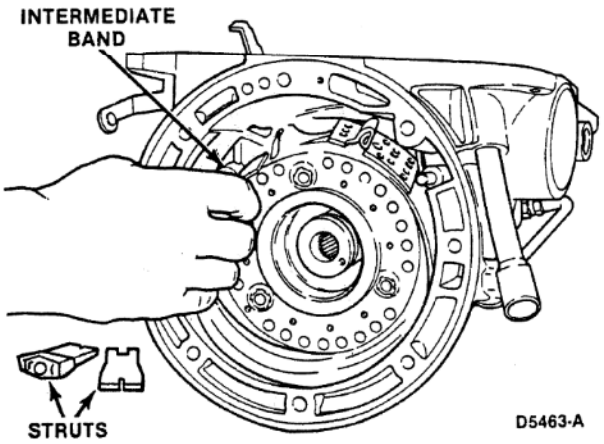
12. Loosen the locknut on the intermediate band adjuster screw.



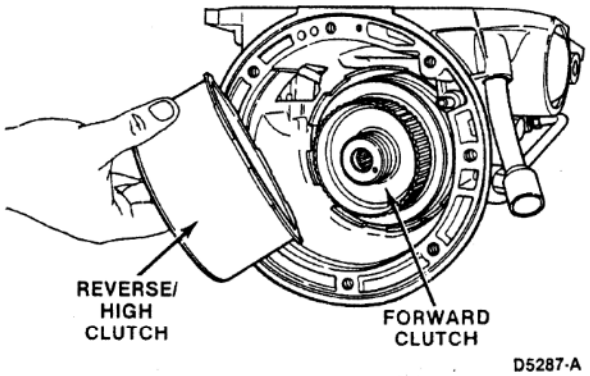
13. Back out the intermediate band adjuster screw.



14. Remove the intermediate band and struts.



15. Remove the reverse/high clutch.

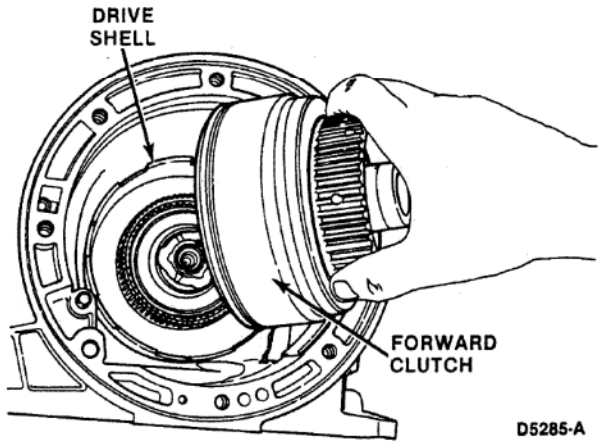


DISASSEMBLY AND ASSEMBLY

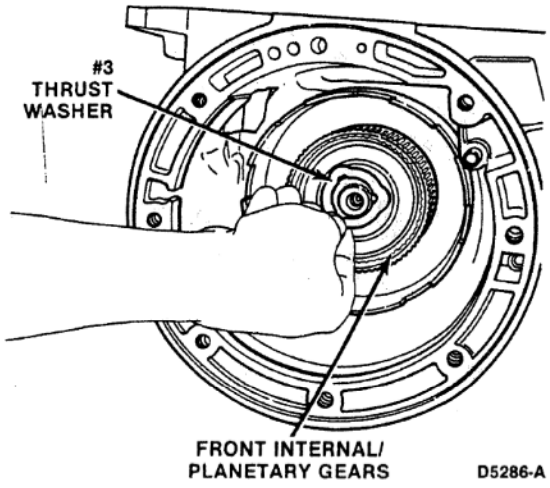
TRANSMISSION

Disassembly (Continued)

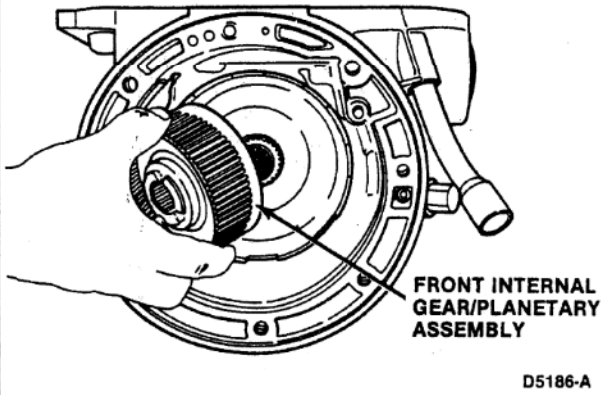
16. Remove the forward clutch.



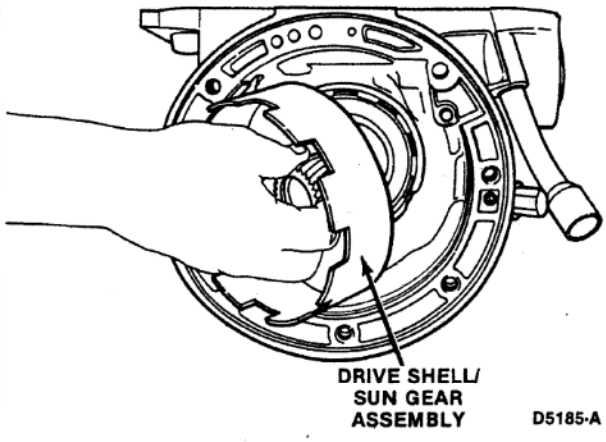
17. Remove the No. 3 thrust washer.



18. Remove the front internal gear/planetary assembly.



19. Remove the drive shell/sun gear assembly.

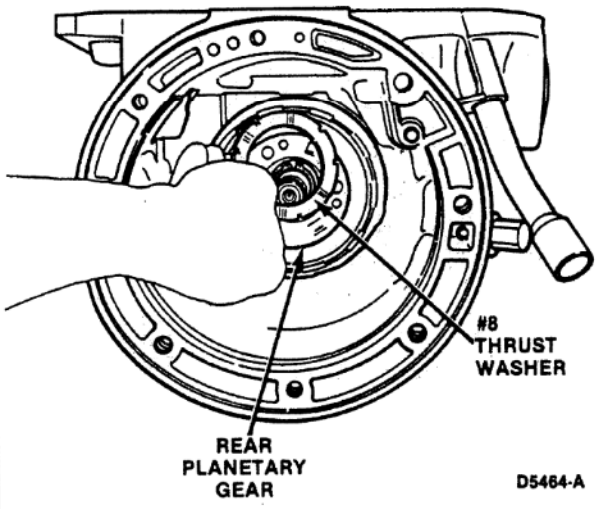


DISASSEMBLY AND ASSEMBLY

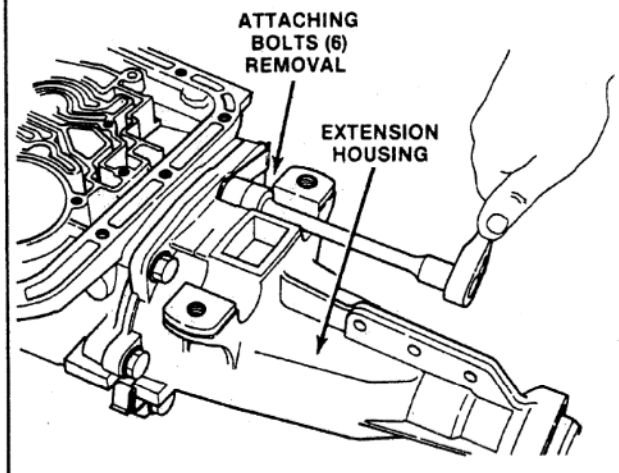
TRANSMISSION

Disassembly (Continued)

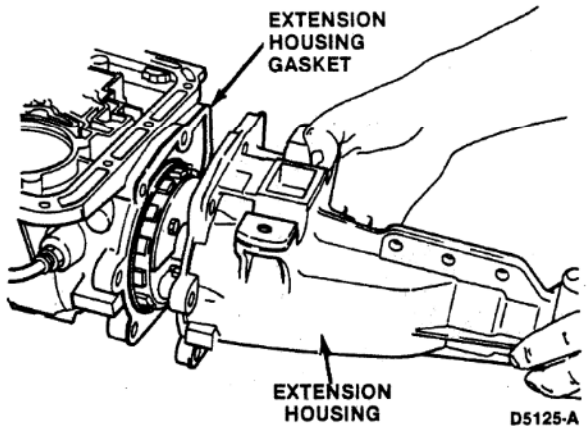
20. Remove thrust washer (No. 8) from the rear planetary carrier.



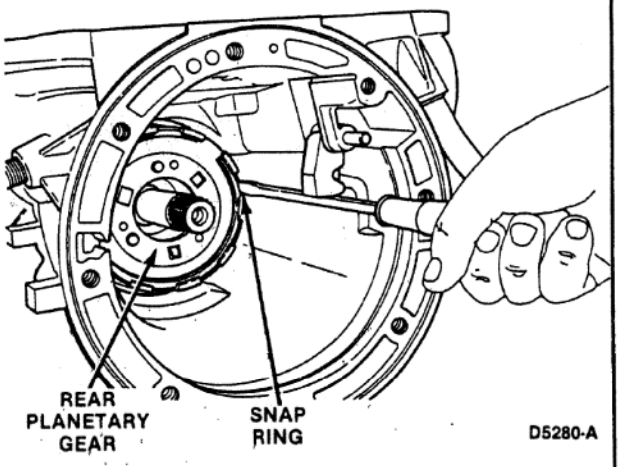
21. Remove the extension housing attaching bolts.



22. Remove the extension housing and gasket.



23. Remove the rear planetary snap ring.

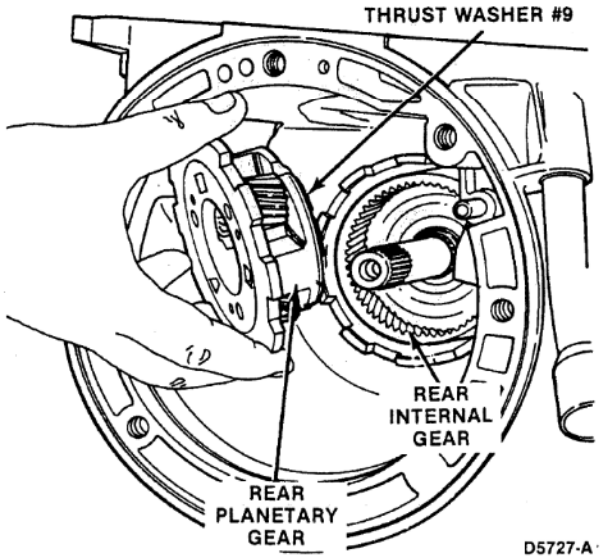


DISASSEMBLY AND ASSEMBLY

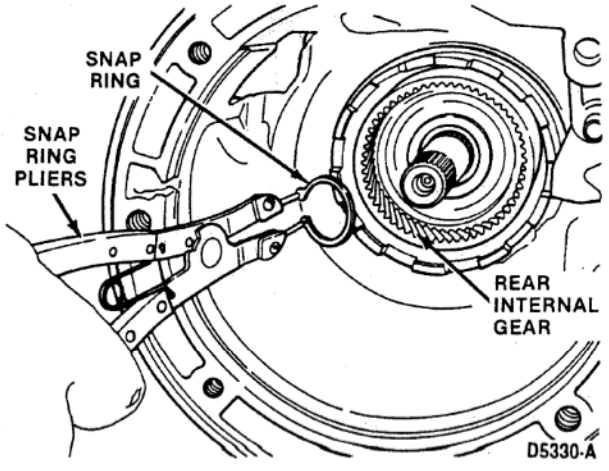
TRANSMISSION

Disassembly (Continued)

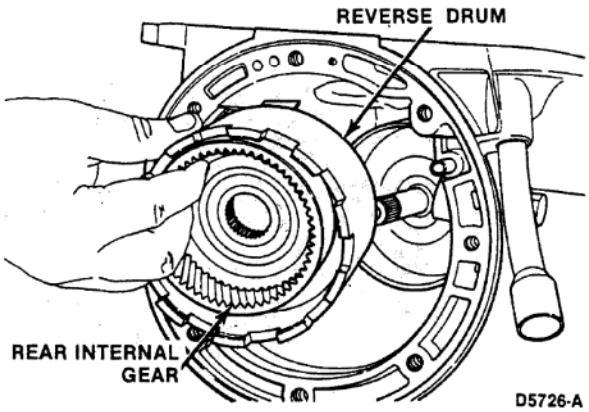
24. Remove the rear planetary gear and thrust washer (No. 9).



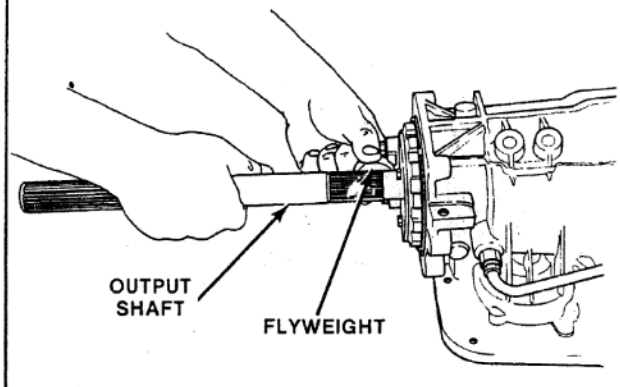
25. Remove the rear internal gear snap ring.



26. Remove the rear internal gear and the reverse drum/one-way clutch assembly.



27. Remove the output shaft with the governor flyweight, spring, and valve.

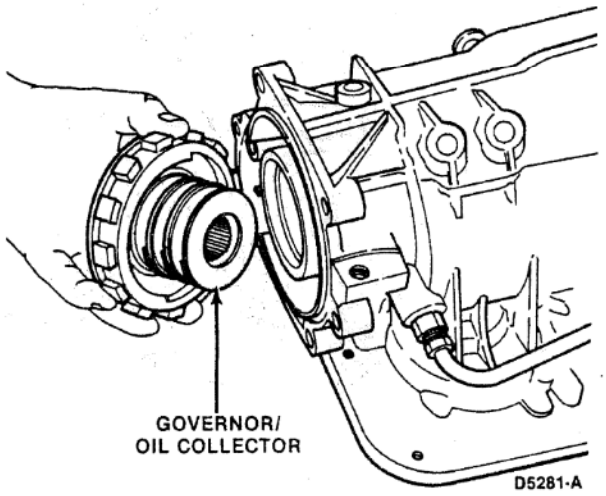


DISASSEMBLY AND ASSEMBLY

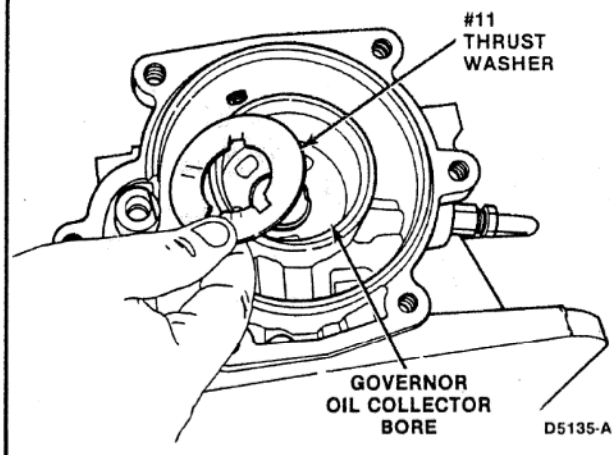
TRANSMISSION

Disassembly (Continued)

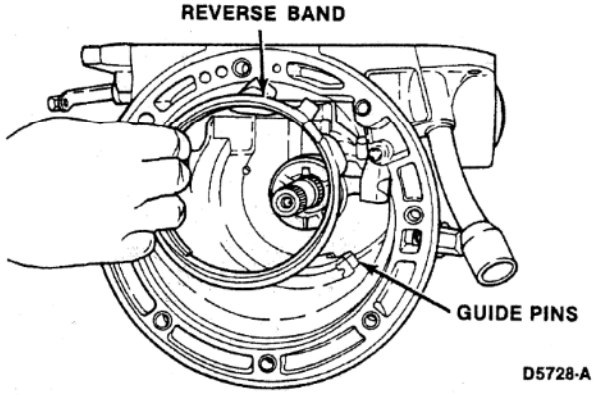
28. Remove the governor/oil collector body assembly.



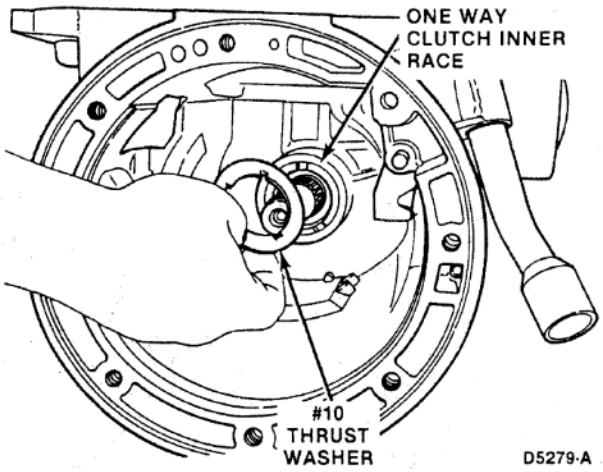
29. Remove the No. 11 thrust washer from the governor/oil collector bore.



30. Remove the reverse band.



31. Remove the No. 10 thrust washer from the one-way clutch inner race.



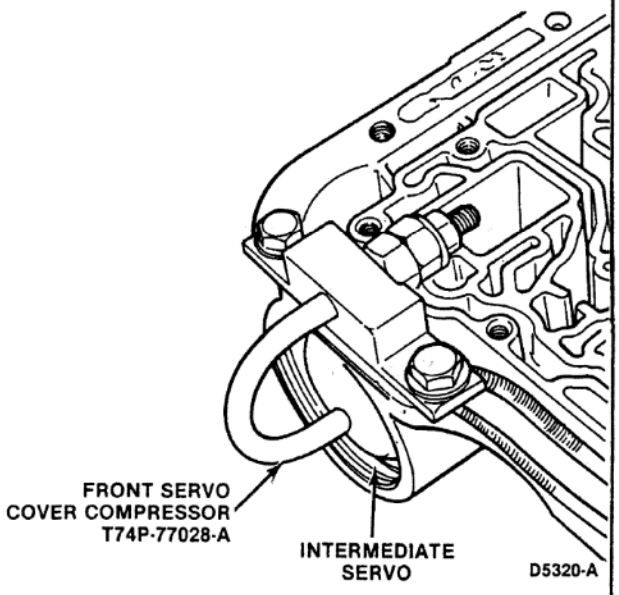
NOTE: The one-way clutch inner race is pressed into the case and cannot be removed.

DISASSEMBLY AND ASSEMBLY

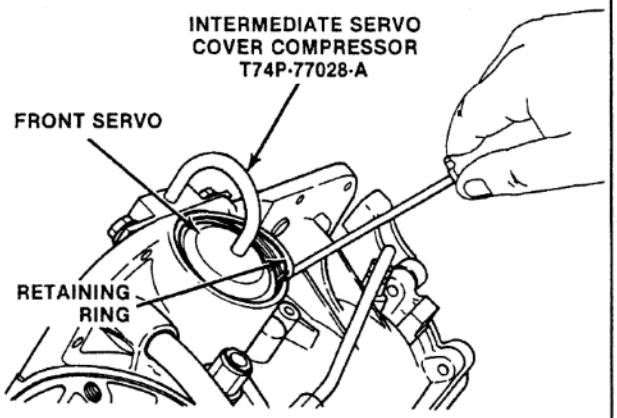
TRANSMISSION

Disassembly (Continued)

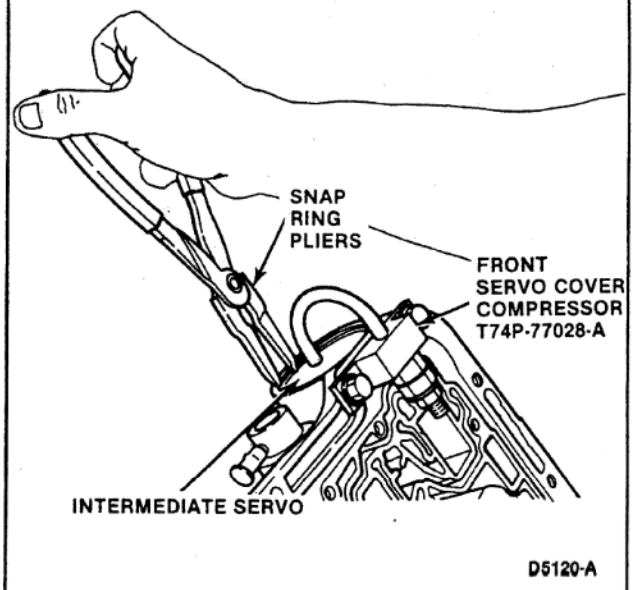
32. Compress the intermediate servo with Front Servo Compressor T74P-77028-A, or equivalent.



33. Remove the intermediate servo retaining ring with a screwdriver.



34. Remove the intermediate servo snap ring with snap ring pliers.

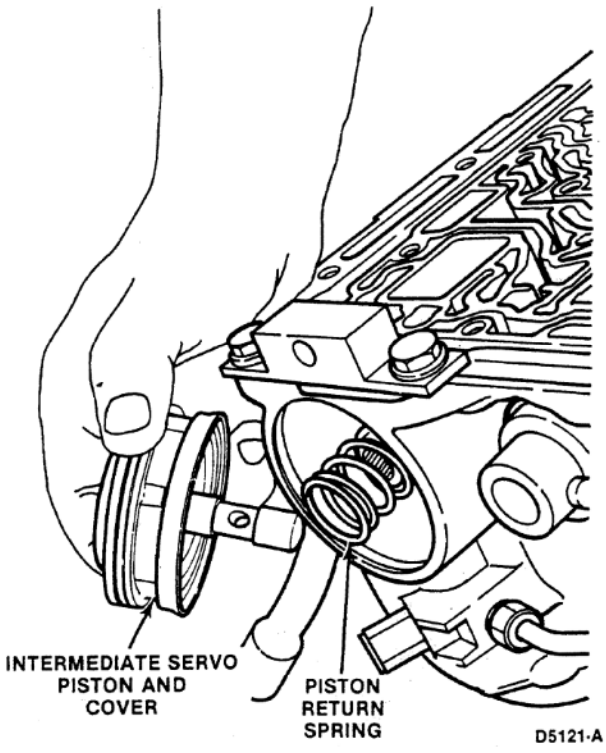


DISASSEMBLY AND ASSEMBLY

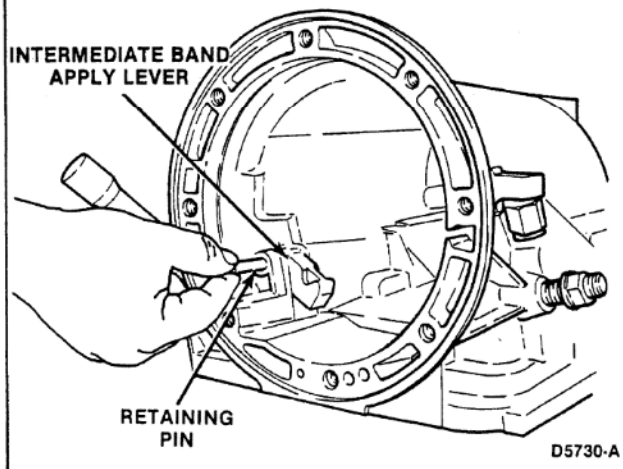
TRANSMISSION

Disassembly (Continued)

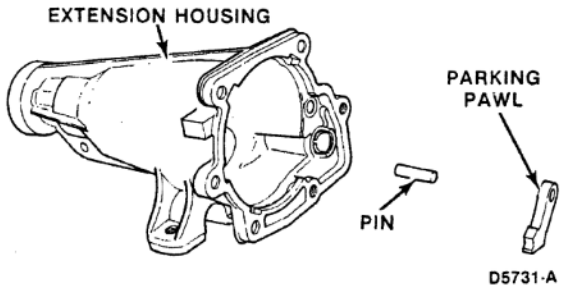
35. Remove the intermediate servo piston, cover and return spring.



36. Remove the intermediate band apply lever retaining pin and the apply lever from the case.



37. Remove the parking pawl, retaining spring, and pin from the extension housing.

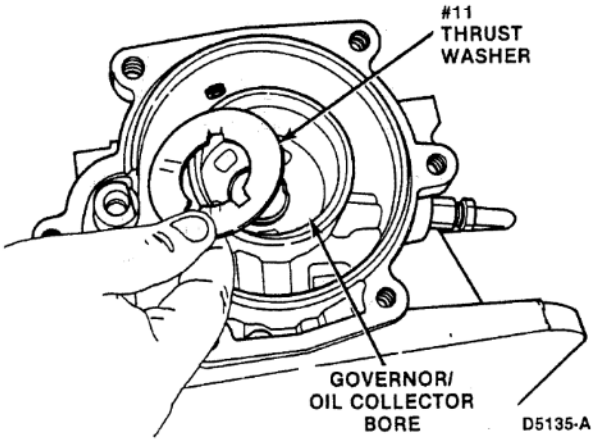


DISASSEMBLY AND ASSEMBLY

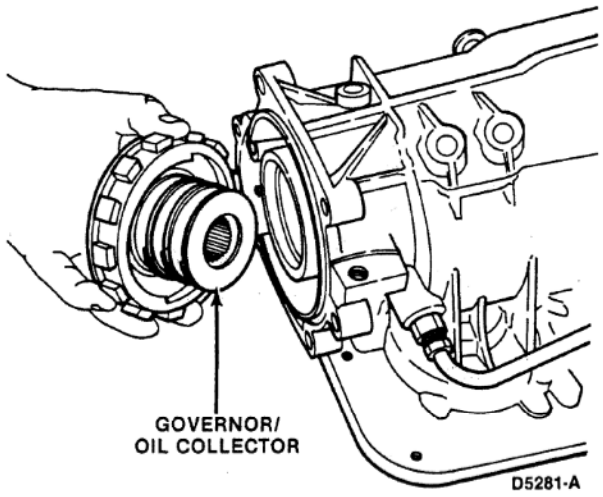
TRANSMISSION

Assembly

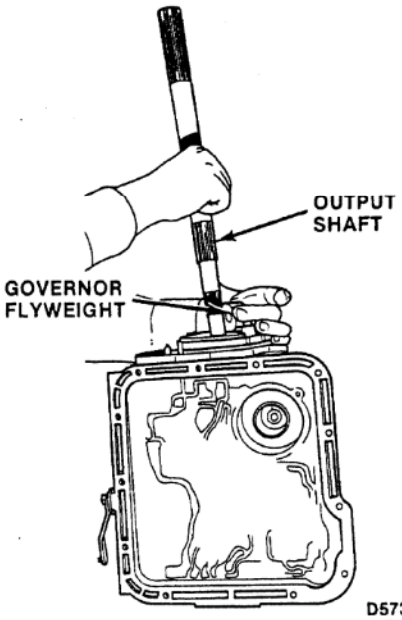
1. Install the oil collector body thrust washer (No. 11) in the case bore.



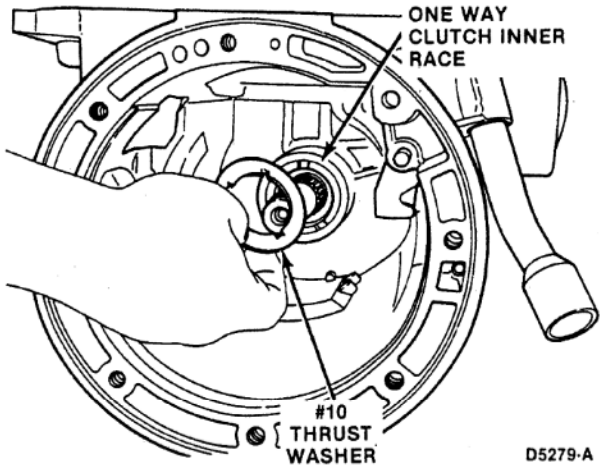
2. Install the governor/oil collector body. Use care to prevent damage to the oil collector body seal rings.



3. Install the valve, spring, and flyweight in the governor body. Hold the flyweight in the governor body and install the output shaft.



4. Install the reverse brake drum thrust washer (No. 10) in the case.

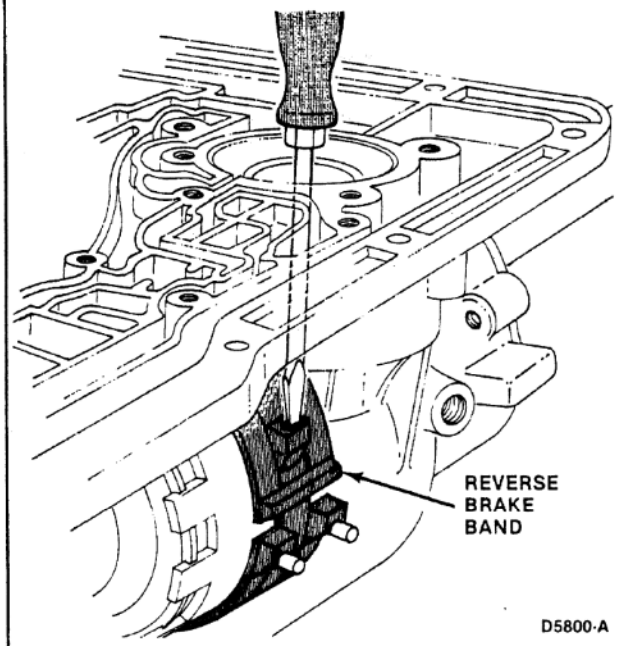


DISASSEMBLY AND ASSEMBLY

TRANSMISSION

Assembly (Continued)

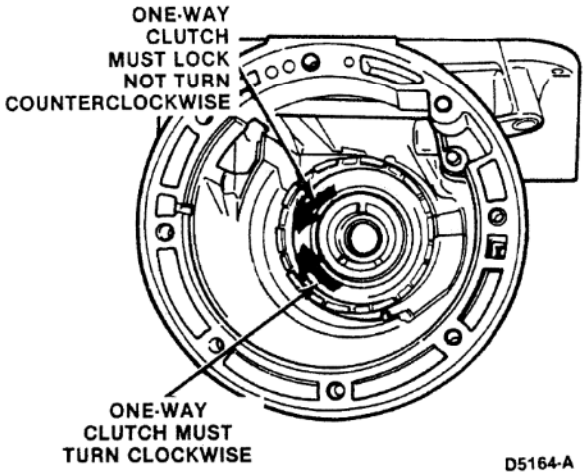
5. Install the reverse brake band. Using a screwdriver, make sure the band lugs engage the anchor pins in the side of the case.



6. Position one-way Clutch Replacing Guide T74P-77193-A inside the one-way clutch.

7. Install the reverse brake drum and remove the one-way clutch guide tool.

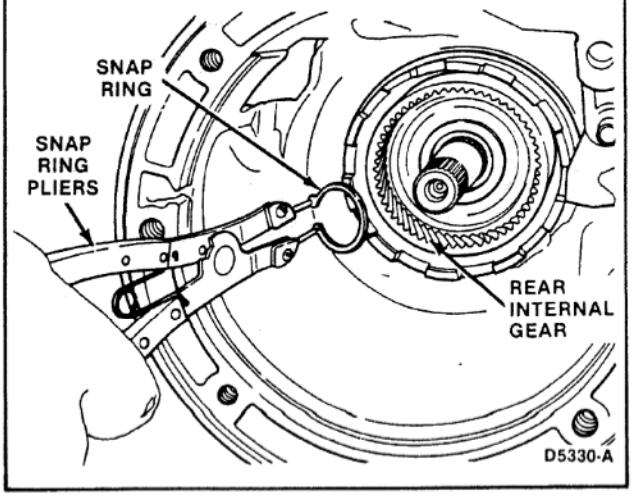
8. Check the operation of the one-way clutch. The reverse drum should not rotate counterclockwise.



9. Install the rear internal gear on the output shaft.

10. Install the rear internal gear snap ring.

    The output shaft may have to be pushed forward to expose the snap ring groove.

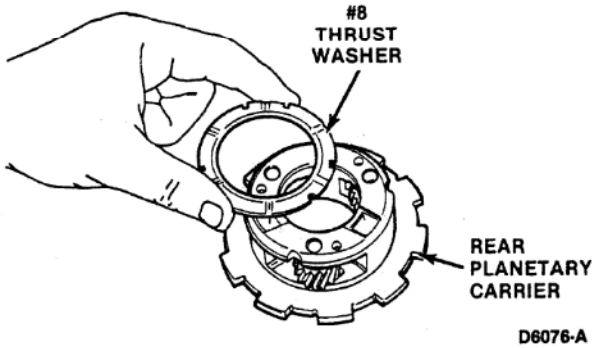


DISASSEMBLY AND ASSEMBLY

TRANSMISSION

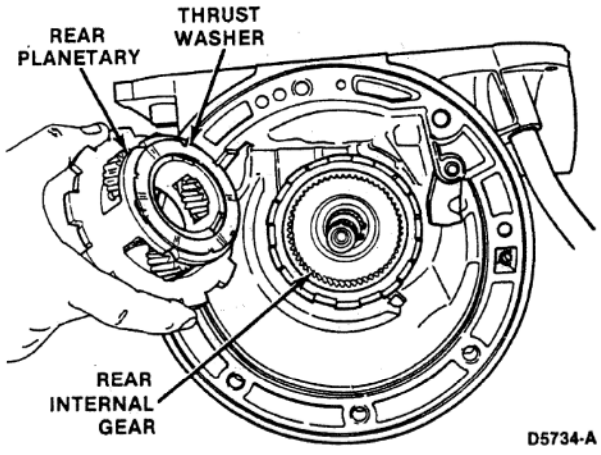
Assembly (Continued)

11. Install the planetary thrust washer (No. 9) on the rear planetary carrier.

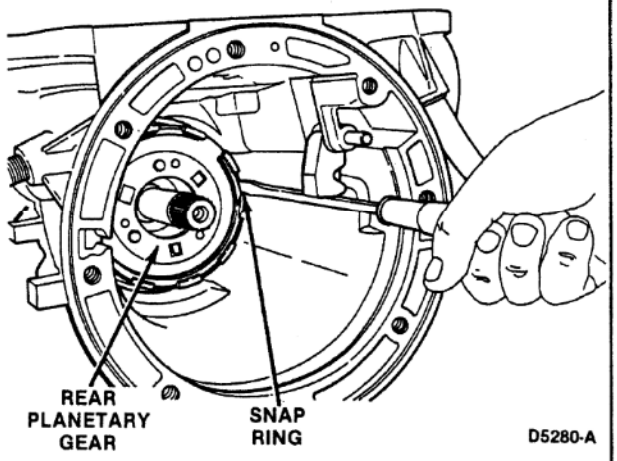


Petroleum jelly can be used to hold the thrust washer in position.

12. Install the rear planetary and thrust washer No. 9 in the rear internal gear.



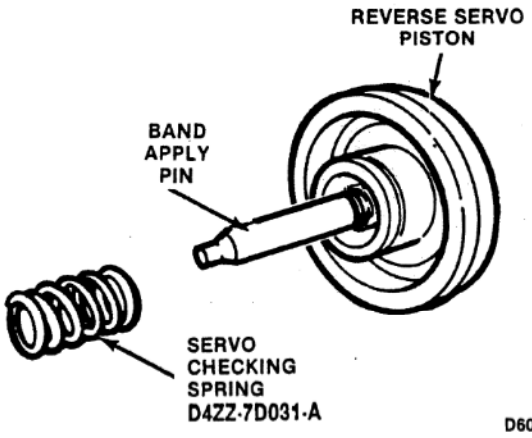
13. Install the rear planetary snap ring.



NOTE: If the transmission case, rear servo piston, or reverse brake band has been replaced, the length of the band apply pin must be checked.

- If a pin length check has to be made, proceed to the next step.
- If the pin length is assumed to be right, proceed to step 25.

14. Install Servo Checking Spring D4ZZ-7D031-A, or equivalent, on the reverse servo apply pin.

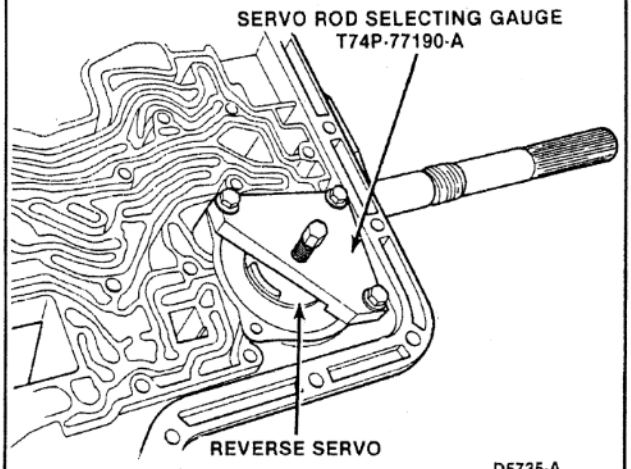


DISASSEMBLY AND ASSEMBLY

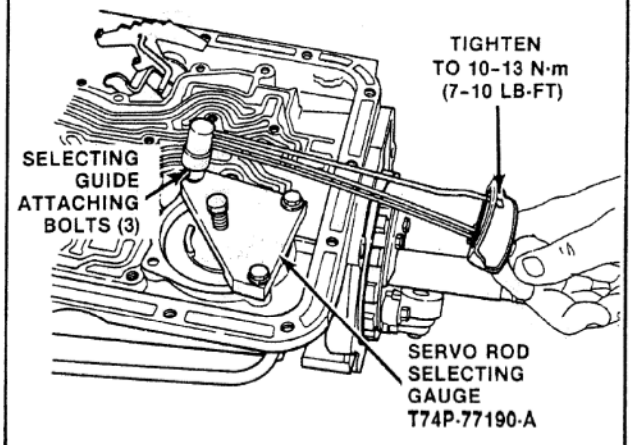
TRANSMISSION

Assembly (Continued)

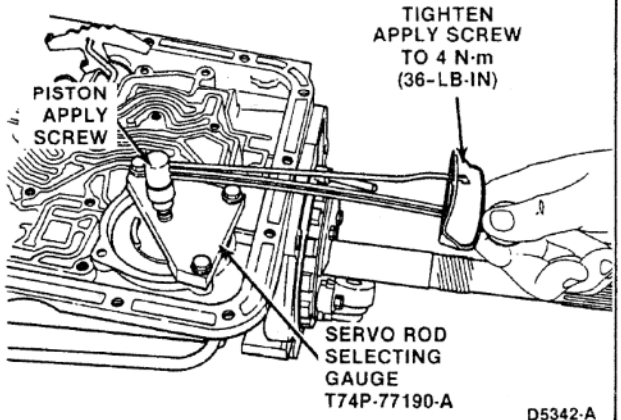
15. Install the reverse servo and checking spring in the case.
16. Position a new servo cover gasket on the transmission case.
17. Using three M6 × 30 bolts, attach Servo Rod Selecting Gauge T74P-77190-A to the transmission case.



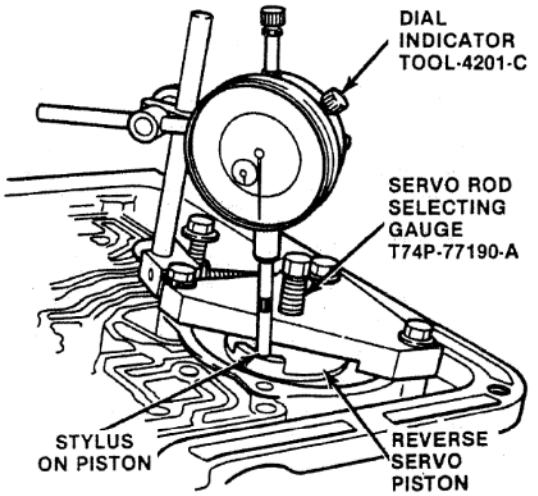
18. Tighten the tool attaching bolts to 10 to 14 N·m (7 to 10 lb-ft).



19. Tighten the selecting gauge adjusting screw to 4 N·m (36 lb-in.).



20. Mount Dial Indicator TOOL-4201-C, or equivalent, on the case with the indicator stylus contacting one of the three servo piston pads accessible through the cutout on the tool.



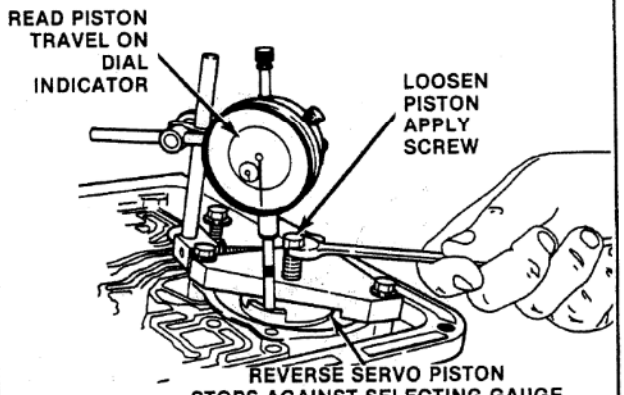
21. Zero the dial indicator.

DISASSEMBLY AND ASSEMBLY

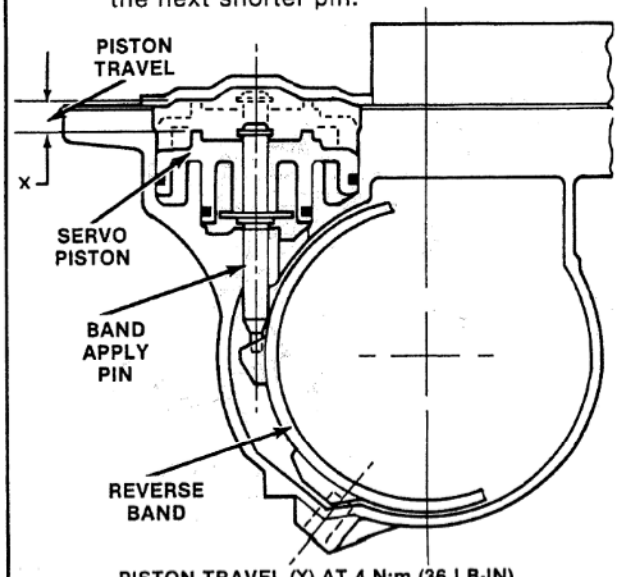
TRANSMISSION

Assembly (Continued)

22. Loosen the selecting gauge adjusting screw until the servo piston stops against the bottom of the tool.



23. Read and record the amount of piston travel on the dial indicator.
    - If the dial indicator reads between 3 and 5.6 mm (.120 and .220 in.), piston travel is within specification and the apply pin length is correct.
    - If the dial indicator reads below 3 mm (.120 in.), the apply pin length is too long. Install the next shorter pin.



- If the dial indicator reads above 5.6 mm (.220 in.), the apply pin length is too short. Install the next longer pin.

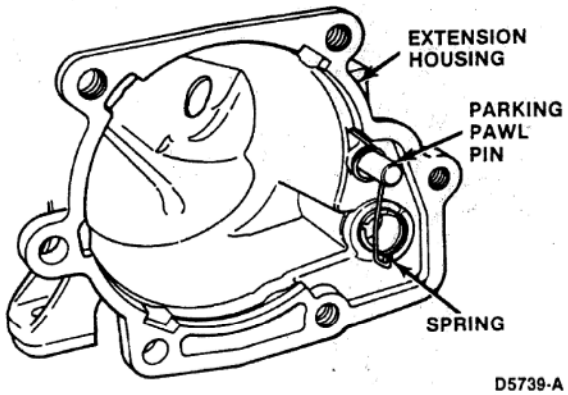
The apply pins are available in three different lengths. Using the chart below, identify the out-of-specification pin and then select the correct pin length.

Length — mm	Length — Inches	I.D.
54-53mm	2.112-2.085	1 Groove
51-50mm	2.014-1.986	No Groove
49-48mm	1.915-1.888	2 Grooves

CD3094-B

24. Remove the selecting gauge and reverse servo. If necessary, replace the servo apply pin.

25. Install the parking pawl pin and spring on the extension housing as shown below.

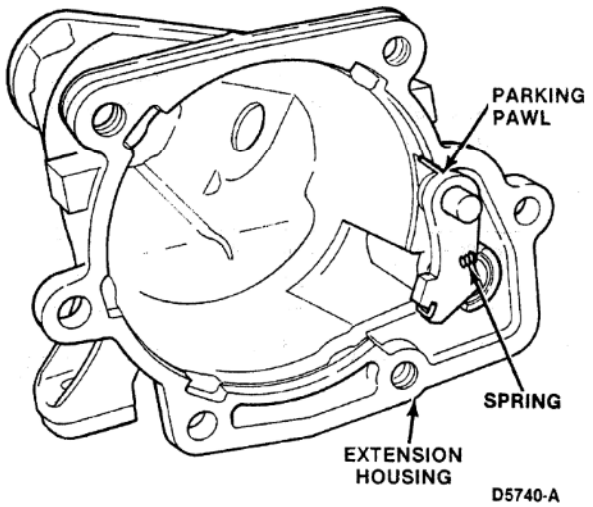


DISASSEMBLY AND ASSEMBLY

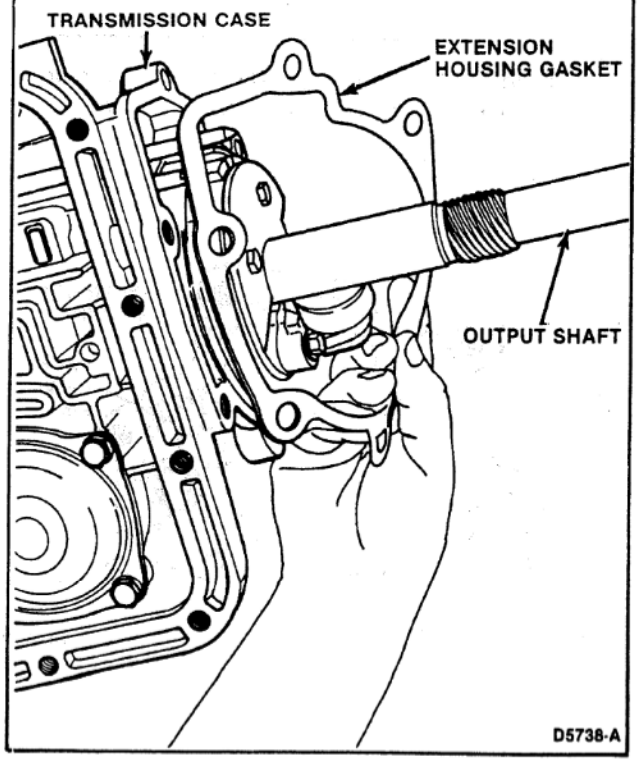
TRANSMISSION

Assembly (Continued)

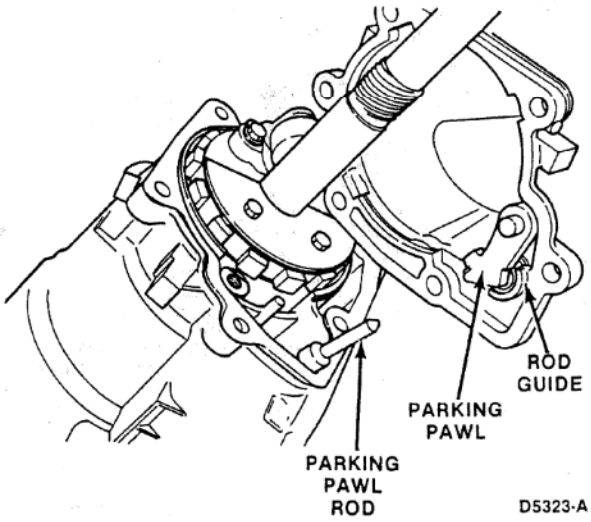
26. Install the parking pawl.



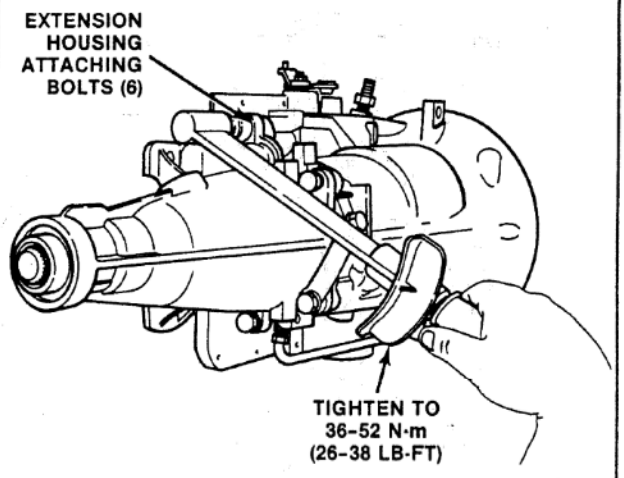
27. Install a new extension housing gasket.



28. Position the extension housing on the case. Make sure the parking pawl actuating rod is properly aligned before seating the housing against the case.



29. Install the extension housing attaching bolts and tighten to 36 to 52 N·m (26 to 38 lb-ft).

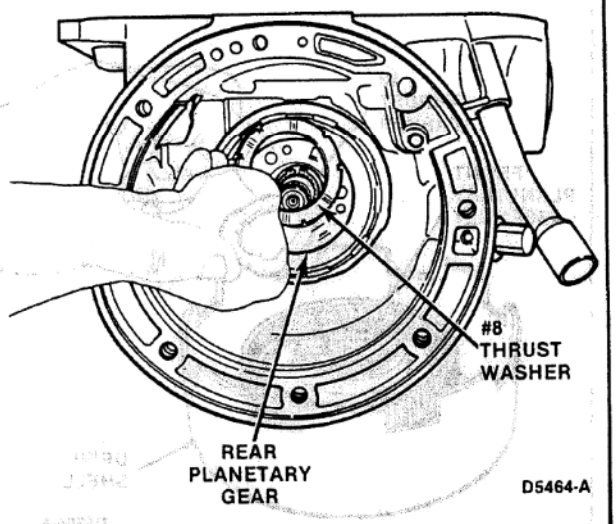


DISASSEMBLY AND ASSEMBLY

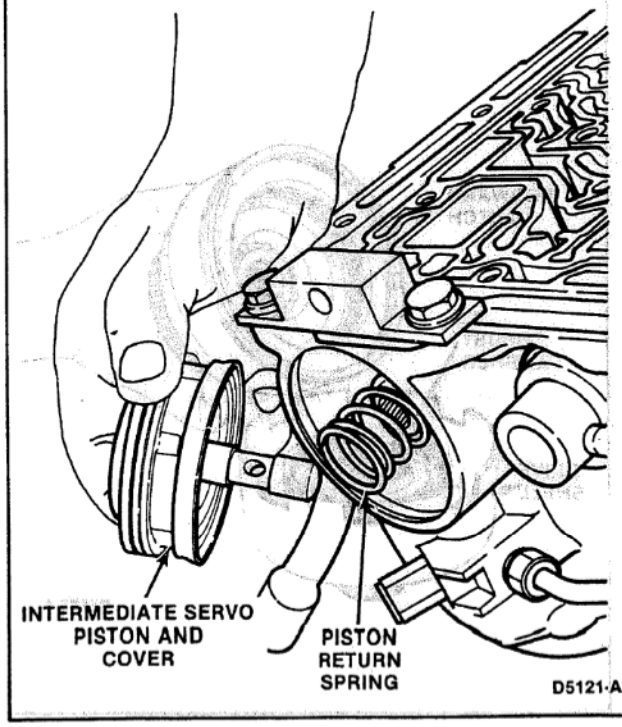
TRANSMISSION

Assembly (Continued)

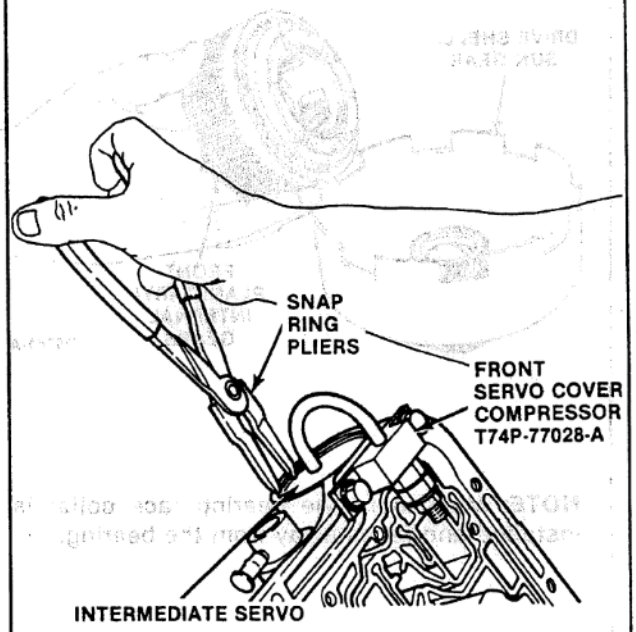
30. Install the No. 8 thrust washer.



31. Install the intermediate servo piston, cover and return spring.



32. Compress the intermediate servo cover with Front Servo Cover Compressor T74P-77028-A, or equivalent, and install the snap ring and retaining ring.

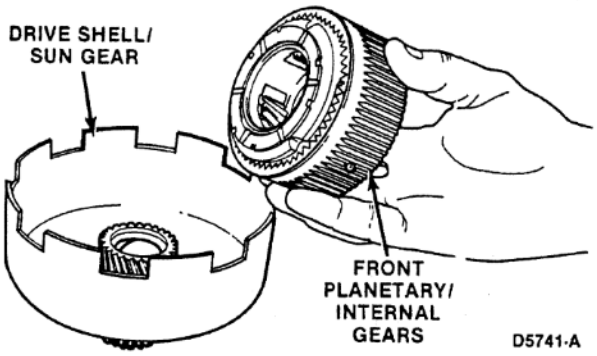


DISASSEMBLY AND ASSEMBLY

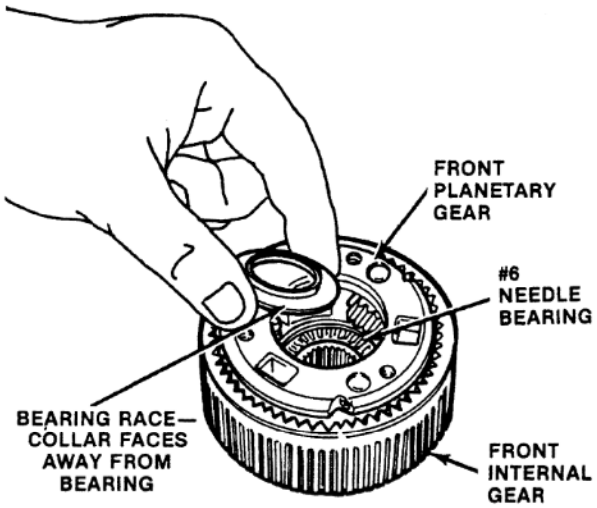
TRANSMISSION

Assembly (Continued)

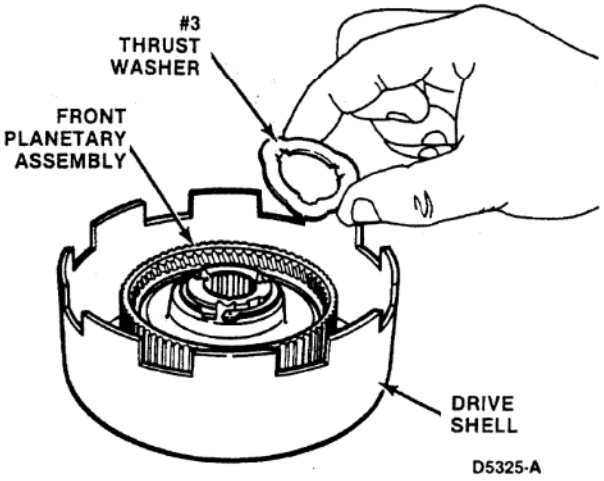
33. Install the front planetary/internal gear assembly in the drive shell.



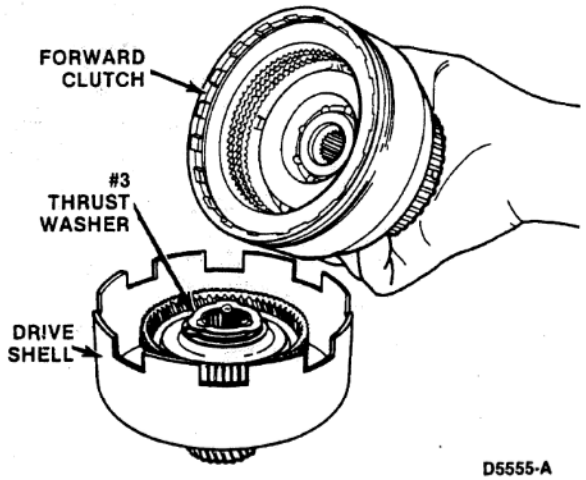
NOTE: Make sure the bearing race collar is installed and faces away from the bearing.



34. Install the No. 3 thrust washer on the front planetary assembly.



35. Install the forward clutch in the drive shell.

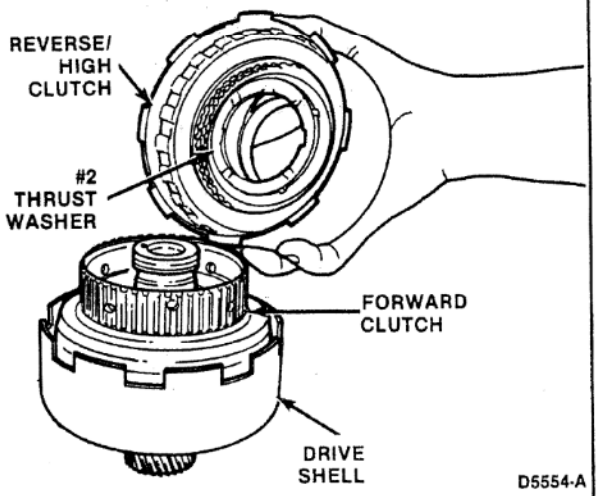


DISASSEMBLY AND ASSEMBLY

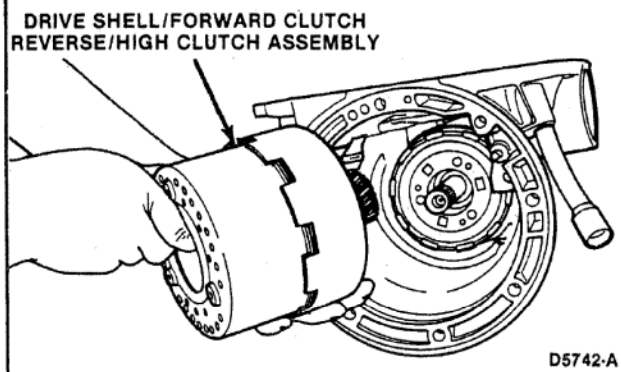
TRANSMISSION

Assembly (Continued)

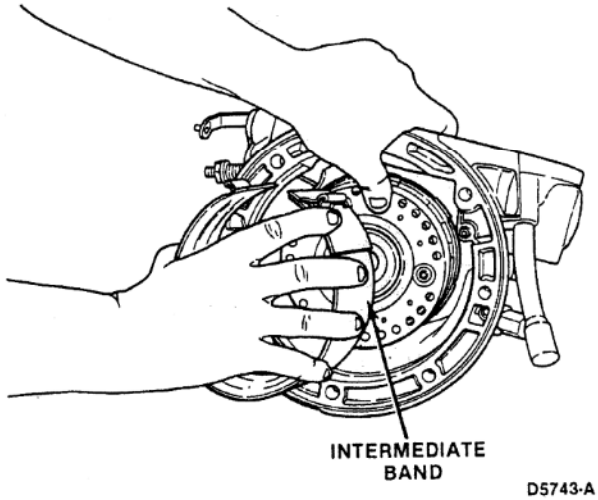
36. Install the reverse/high clutch on the forward clutch.



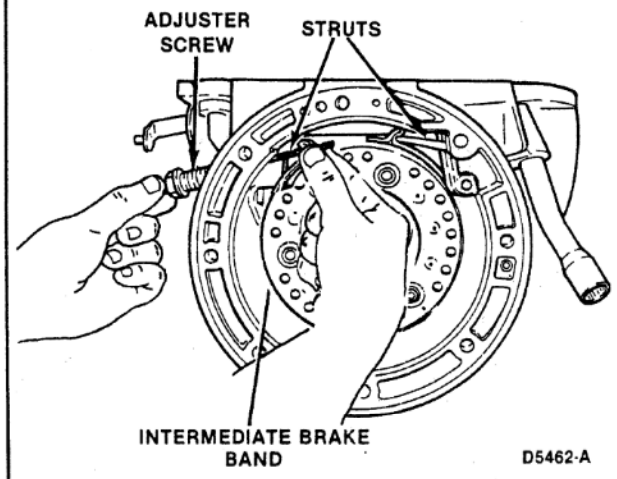
37. Install the drive shell/forward clutch/reverse/high clutch assembly in the case.



38. Install the intermediate band.



39. Install the intermediate band struts and tighten the adjusting screw enough so that the struts are held in place.

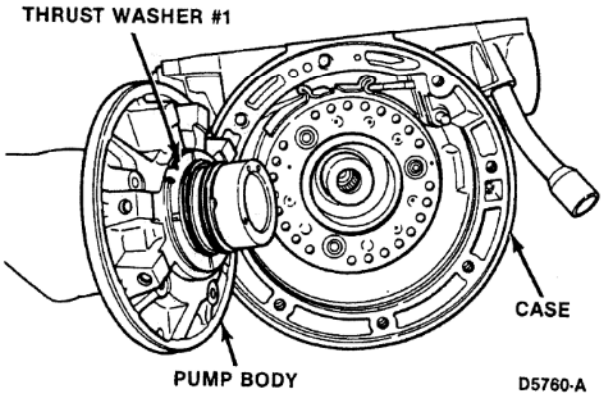


DISASSEMBLY AND ASSEMBLY

TRANSMISSION

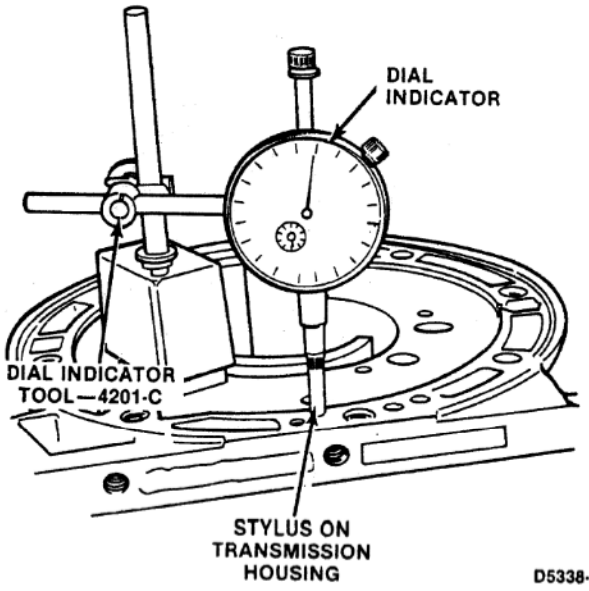
Assembly (Continued)

40. Being careful not to damage the oil seals, turn the transmission so the extension housing points downward. Install the pump body with the No. 1 thrust washer in the case.

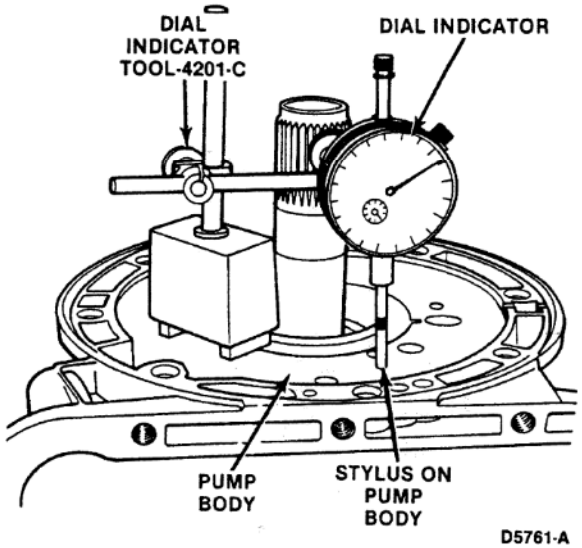


Be sure the pump body is correctly engaged, the pump body must be below the level of the case gasket surface.

41. Mount the Dial Indicator TOOL-4201-C, or equivalent, on the pump body with the stylus resting on the transmission housing. Zero the dial indicator.



42. Swing the gauge around so the stylus rests on the pump body.



Check the reading on the dial indicator. This reading is the amount of endplay. Note for later reference.

43. Move the Dial Indicator to the opposite side of the pump (180 degrees) and repeat Steps 41 and 42.

44. Find the average of the two endplay readings. Endplay should be from .025 mm to .64 mm (.001 to .025 in.). If the reading exceeds these limits, replace the No. 1 thrust washer. Use the chart below to select the proper thrust washer thickness.

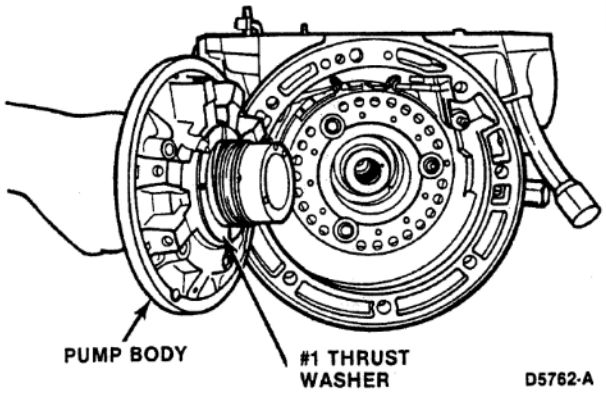
Transmission End Play	Part Number	Thickness mm (In.)	Number Stamped On Washer
0.025–0.625 mm (0.001–0.025 in.) without gasket	Selective pump support thrust washer (nylon)		
	84DT-7D014-AA	1.35–1.40 (.053/.055)	1
	84DT-7D014-BA	1.55–1.60 (.060/.062)	2
	84DT-7D014-CA	1.75–1.80 (.068/.070)	3
	84DT-7D014-DA	1.95–2.00 (.076/.078)	4
	84DT-7D014-EA	2.15–2.20 (.084/.086)	5
	84DT-7D014-FA	2.35–2.40 (.092/.094)	6

DISASSEMBLY AND ASSEMBLY

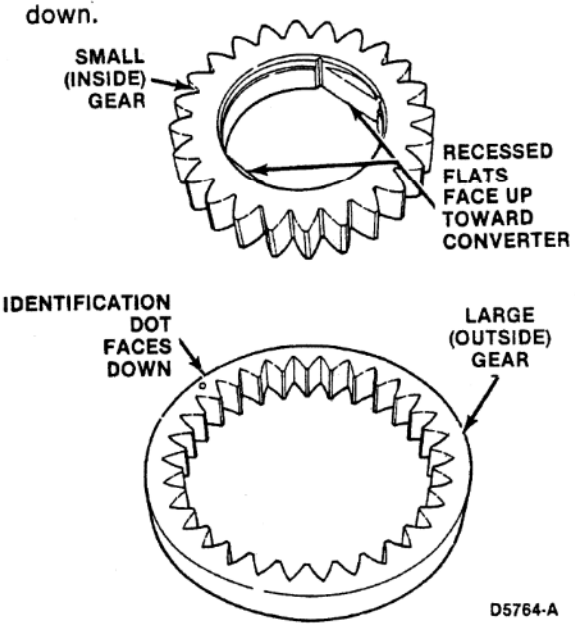
TRANSMISSION

Assembly (Continued)

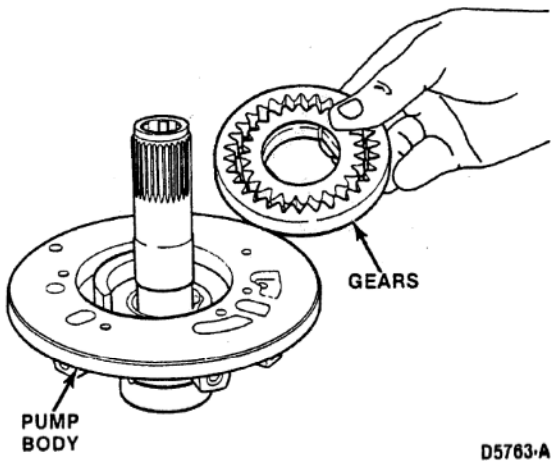
45. Remove the Dial Indicator and the pump body.



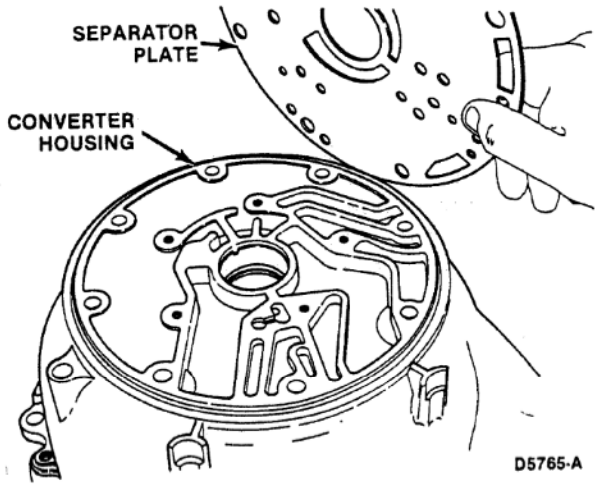
Make sure that the small (inside) gear has the recessed pump drive flat facing up toward the converter and that the large (outside) gear has the indentification dot facing down.



46. Install the inside and outside gears on the pump body.



47. Install the separator plate on the converter housing.

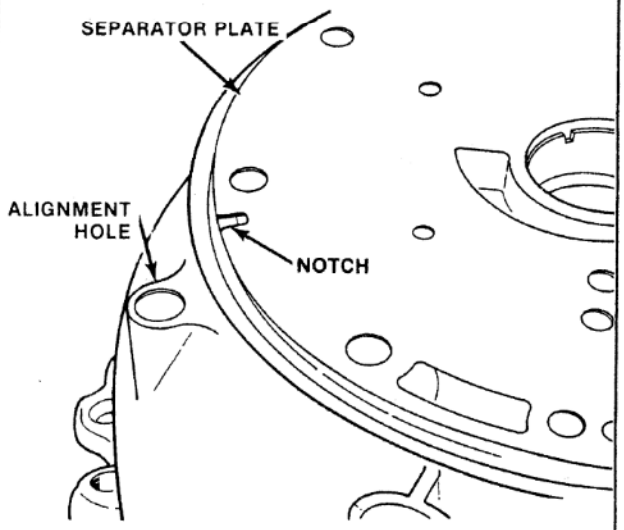


DISASSEMBLY AND ASSEMBLY

TRANSMISSION

Assembly (Continued)

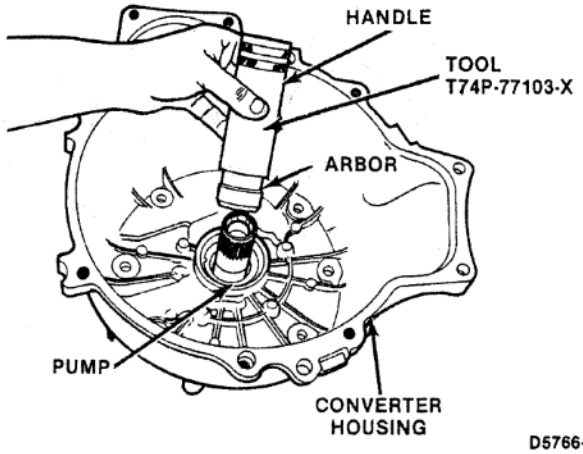
Align the notch in the separator plate with the alignment hole in the side of the converter housing.



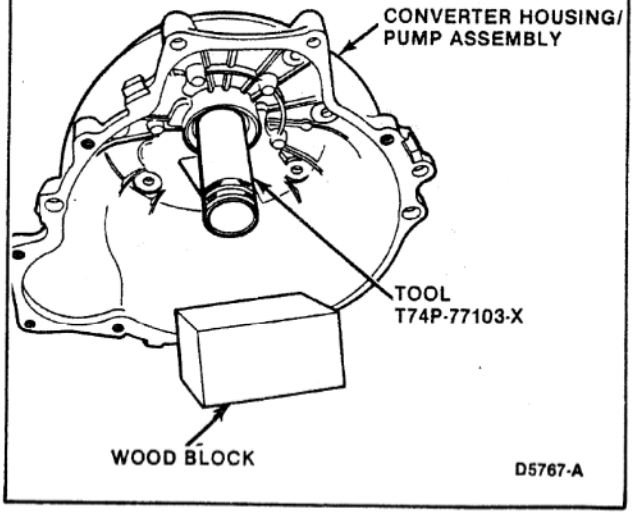
48. Install the pump and attaching bolts on the converter housing and tighten the bolts finger tight.

49. Align the pump, using Tool T74P-77103-X, or equivalent. **This tool must be used and the sleeve gauging surfaces must be in good condition. Otherwise the pump will not be aligned correctly with the converter housing; then seal leakage, pump gear breakage, or bushing failure will result.**

To use the tool, select the arbor with the smallest ID that will fit completely over the pump shaft. Assemble the common handle to the selected arbor and slide the tool down over the shaft until it bottoms against the pump. The outside diameter of the tool arbor will automatically center the pump in the converter housing.



50. Place a block of wood in front of the converter housing/pump assembly and turn the housing over so that the alignment tool rests on the block of wood.

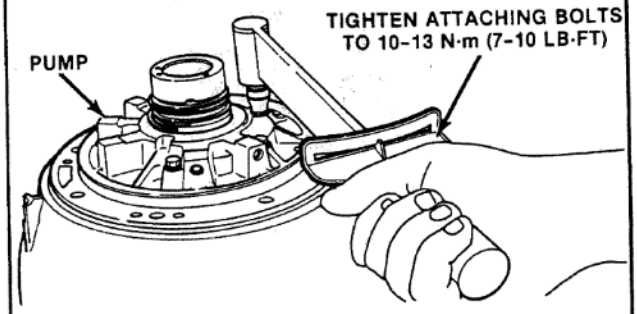


DISASSEMBLY AND ASSEMBLY

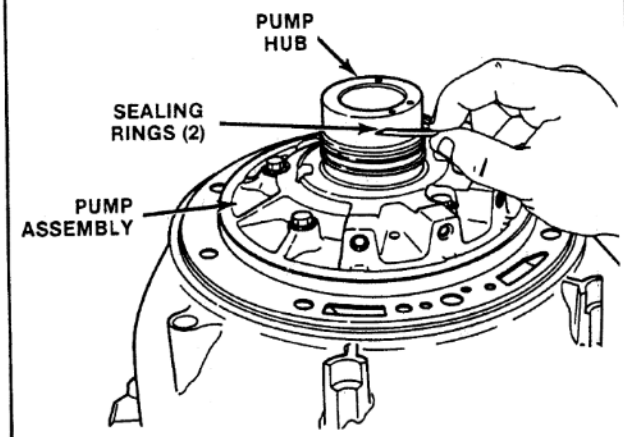
TRANSMISSION

Assembly (Continued)

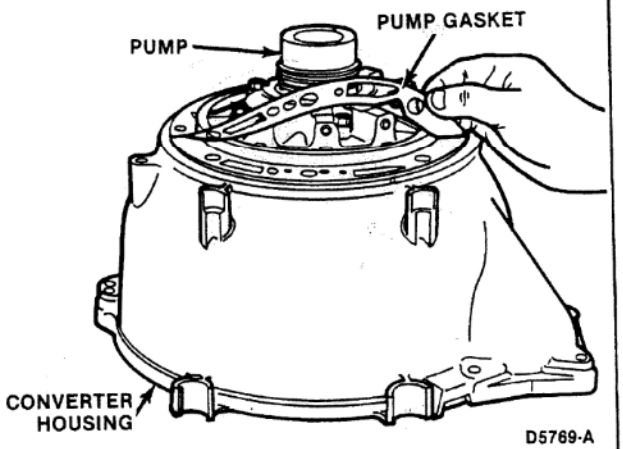
51. Tighten the pump attaching bolts to 10 to 13 N·m (7 to 10 lb-ft).



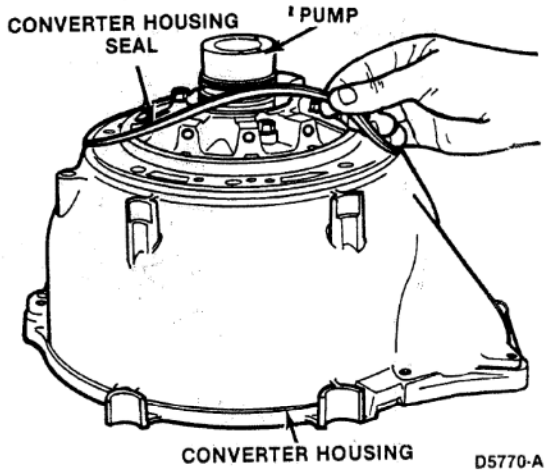
52. Install the seal rings on the pump hub.



53. Install the pump gasket.



54. Install the converter housing seal.

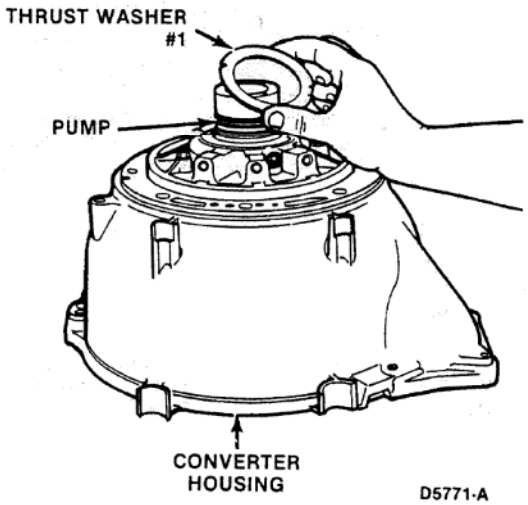


DISASSEMBLY AND ASSEMBLY

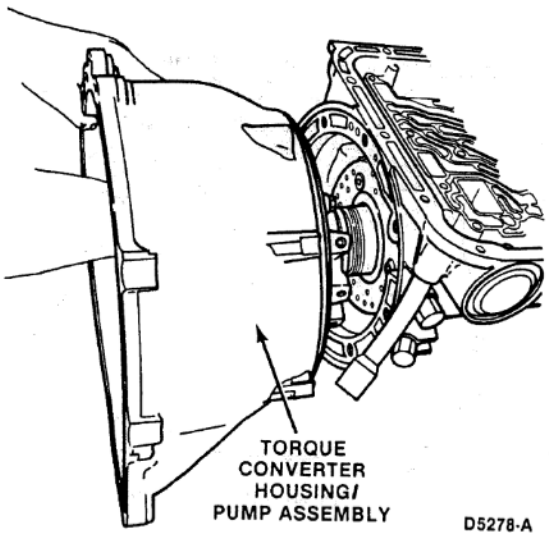
TRANSMISSION

Assembly (Continued)

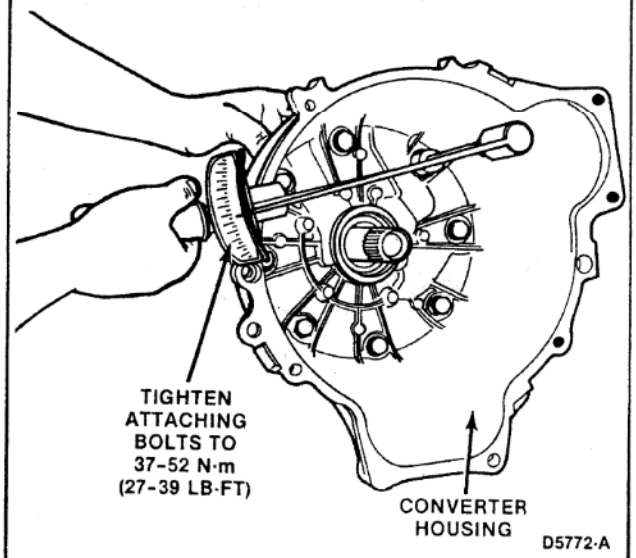
55. Install thrust washer No. 1 on the pump hub.



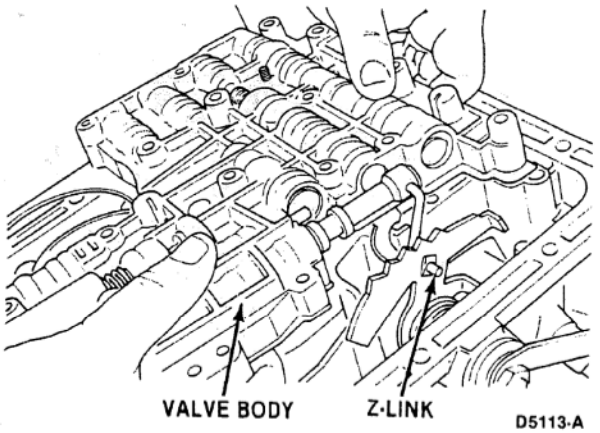
56. Install the converter housing and pump assembly on the case.



57. Install the converter housing attaching bolts, using new aluminum washers. Tighten the bolts to 37 to 52 N·m (27 to 39 lb-ft).



58. Install the valve body with a new separator plate-to-case gasket. As the valve body is lowered into place, insert the selector lever Z-link into the manual valve.

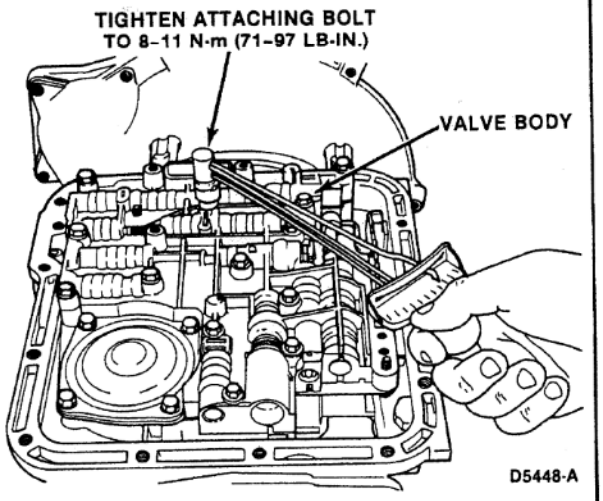


DISASSEMBLY AND ASSEMBLY

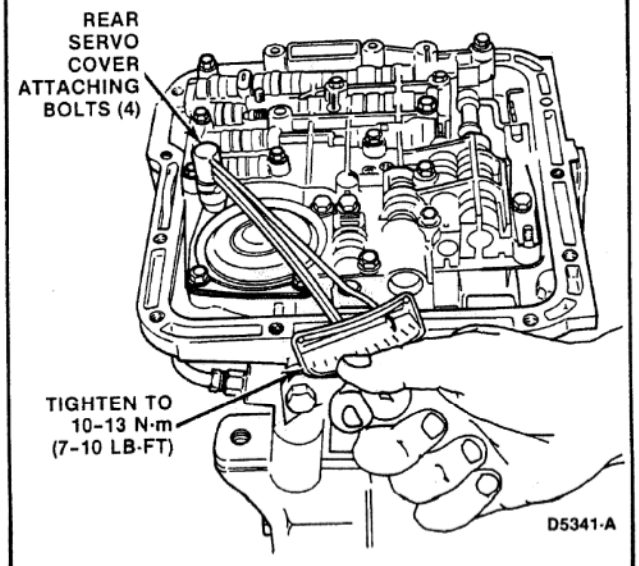
TRANSMISSION

Assembly (Continued)

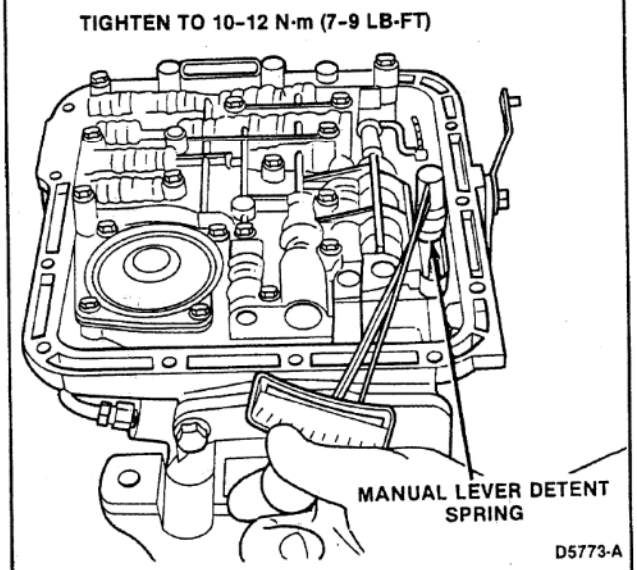
59. Install the valve body attaching bolts and tighten to 8 to 11 N·m (71 to 97 lb-in.).



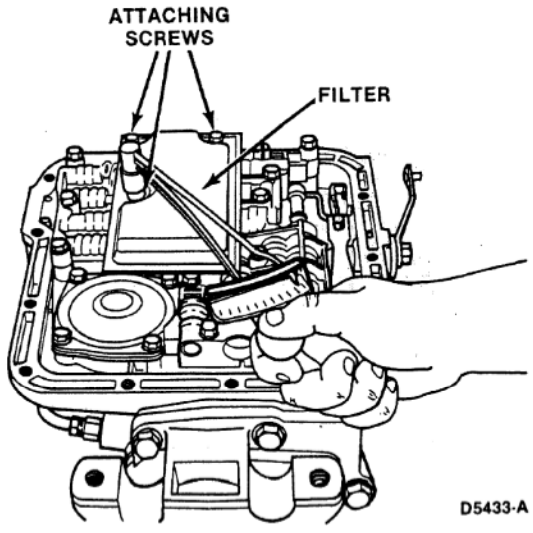
60. Install the rear servo assembly (with a new cover gasket) and tighten the attaching bolts to 10 to 13 N·m (7 to 10 lb-ft).



61. Install the manual lever detent spring attaching bolt and tighten to 10 to 12 N·m (7 to 9 lb-ft).



62. Install the oil filter and gasket. Tighten the attaching screws to 8 to 11 N·m (71 to 97 lb-in.).

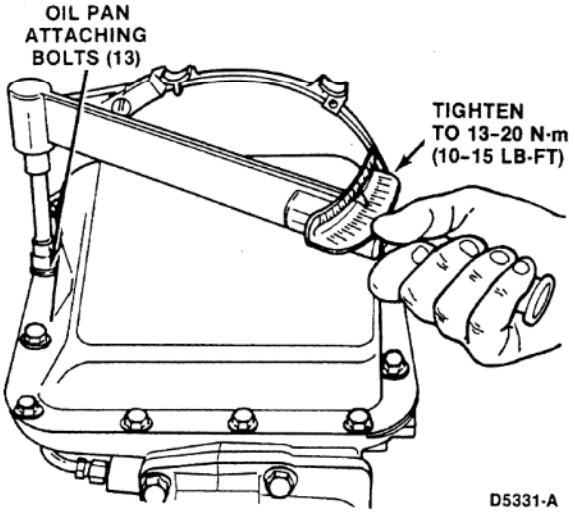


DISASSEMBLY AND ASSEMBLY

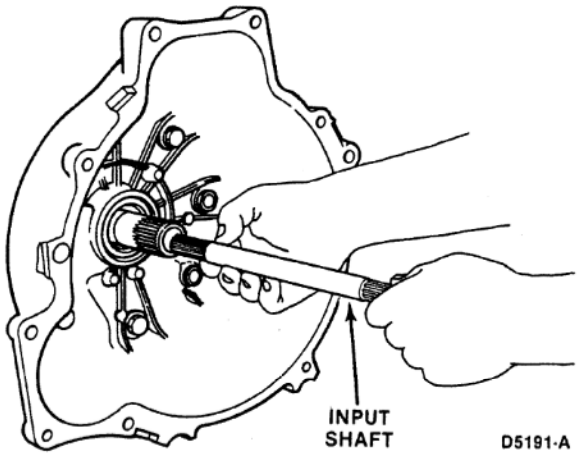
TRANSMISSION

Assembly (Continued)

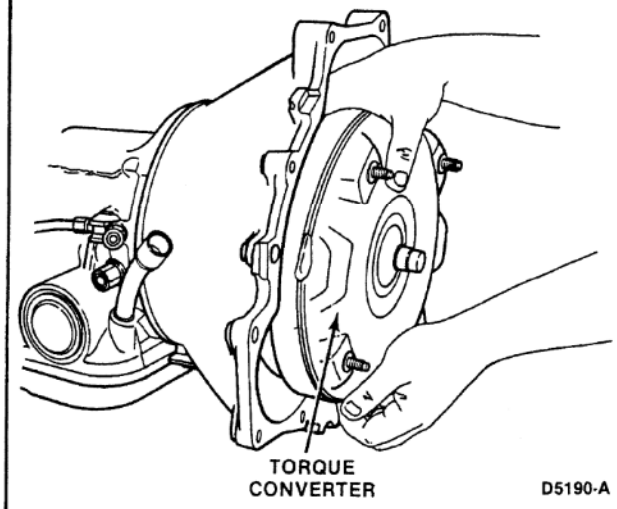
63. Install the oil pan with a new gasket. Tighten the oil pan attaching bolts to 13 to 20 N·m (10 to 15 lb-ft).



64. Install the input shaft.



65. Install the torque converter.



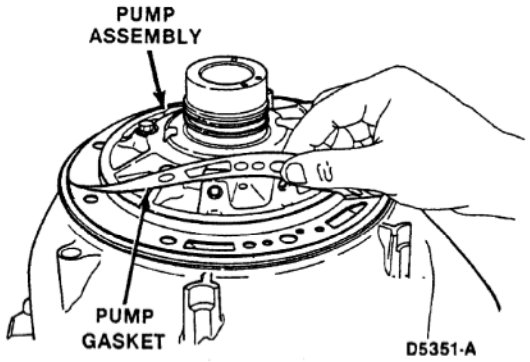
66. Adjust the intermediate brake band. If necessary, refer to the procedure in this section.

SUBASSEMBLIES

PUMP

Disassembly

1. Remove the pump gasket from the pump assembly.

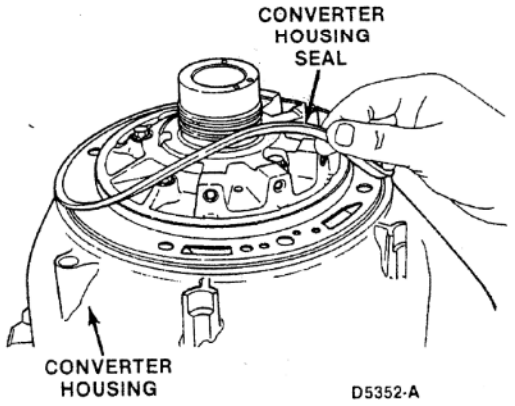


DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

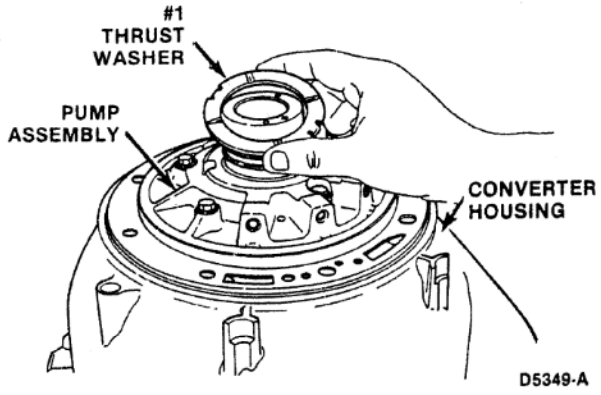
PUMP

Disassembly (Continued)

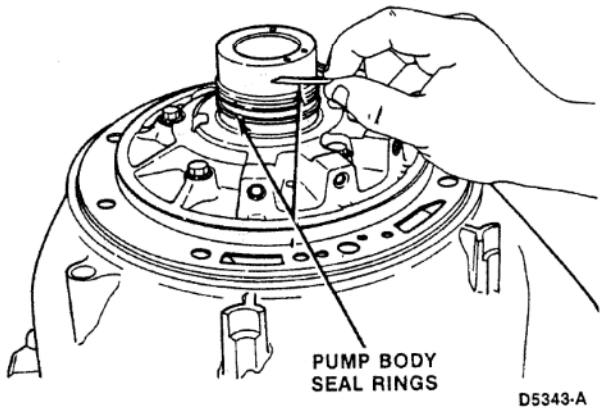
2. Remove the converter housing seal from the converter housing.



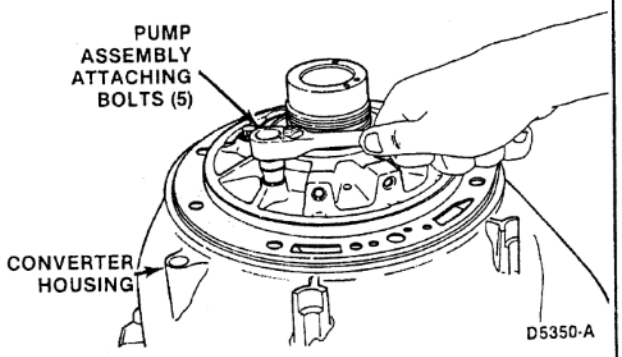
3. Remove the thrust washer (No. 1) from the pump assembly.



4. Remove the seal rings from the pump hub.



5. Remove the pump assembly attaching bolts.

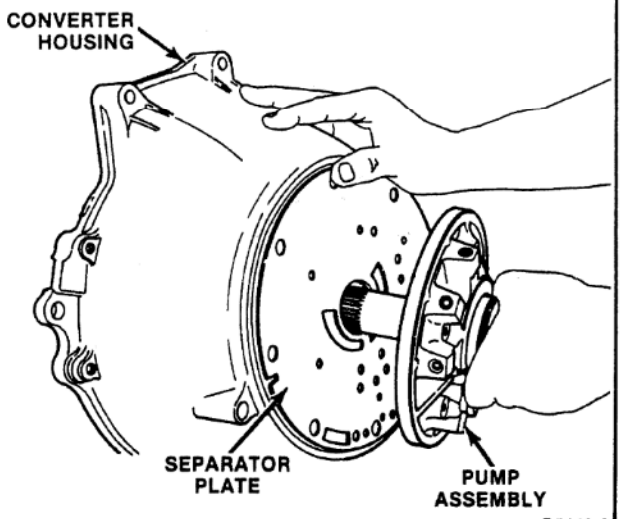


DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

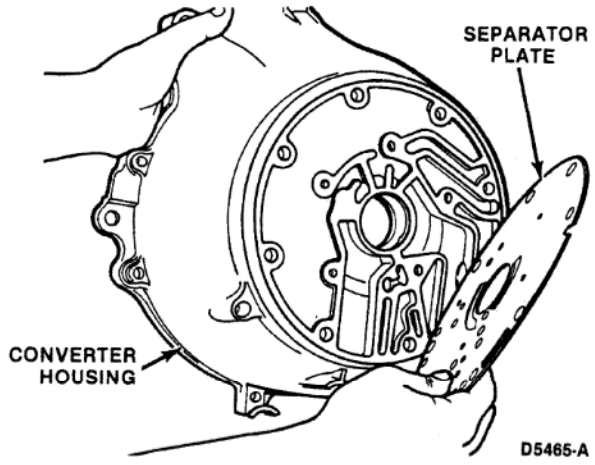
PUMP

Disassembly (Continued)

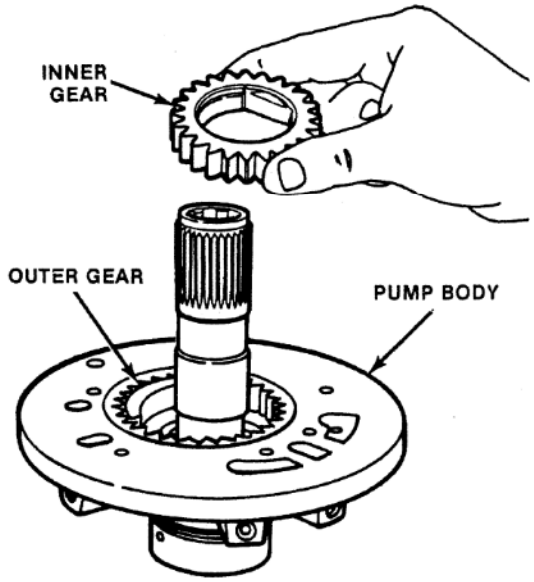
6. Remove the pump assembly from the converter housing.

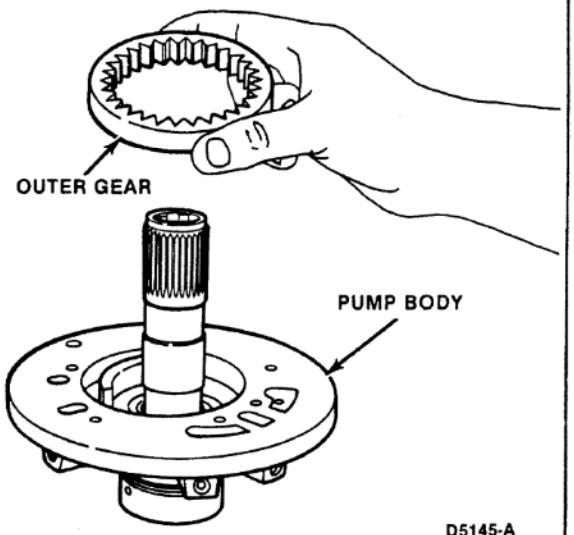


7. Remove the separator plate from the converter housing.



8. Remove the pump gears from the pump body.



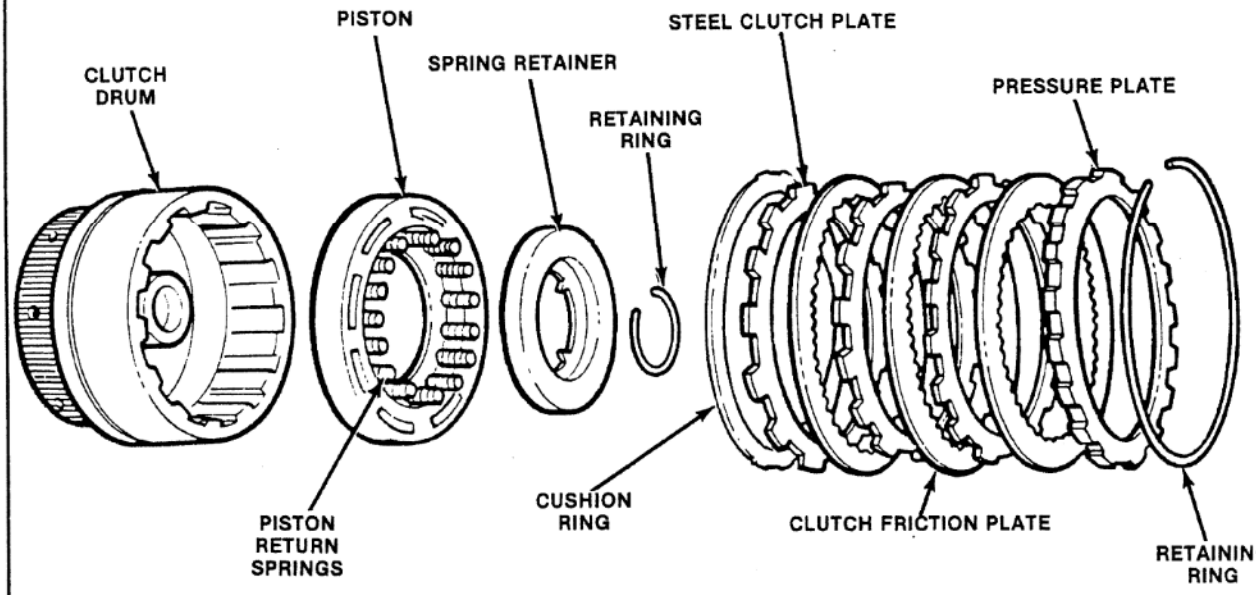


Assembly

Do not assemble the pump at this point. The pump body will be needed during disassembly of the clutches and for an endplay check during assembly of the transmission. Assembly of the pump is included in the transmission assembly procedure.

DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

FORWARD CLUTCH DISASSEMBLED VIEW

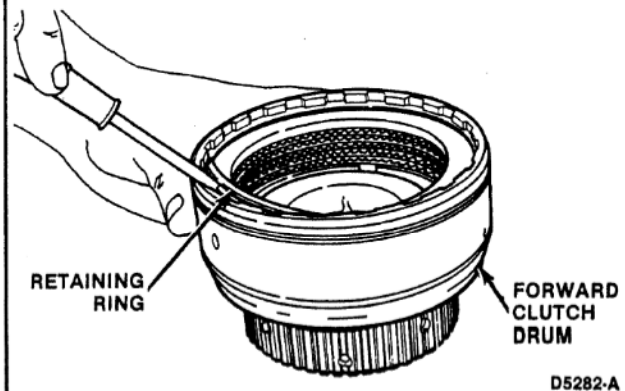


Disassembly

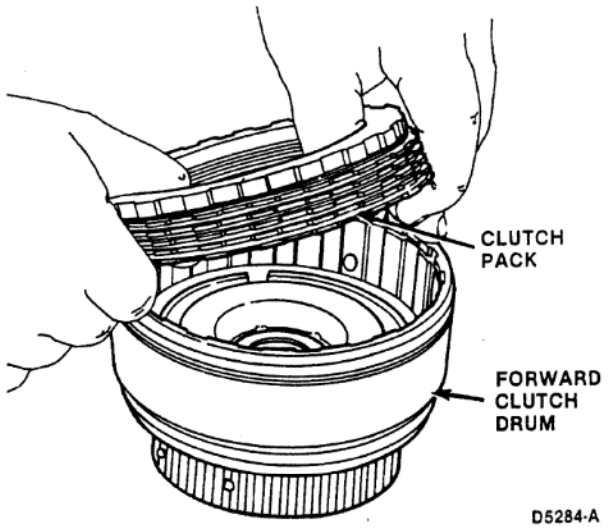
SPECIAL SERVICE TOOLS REQUIRED:

Spring Compressor	T65L-77515-A
Lip Seal Protector	T74P-77548-A
Lip Seal Protector	T74P-77548-B

1. Remove the clutch pack retaining ring.



2. Remove the clutch pack from the clutch drum.

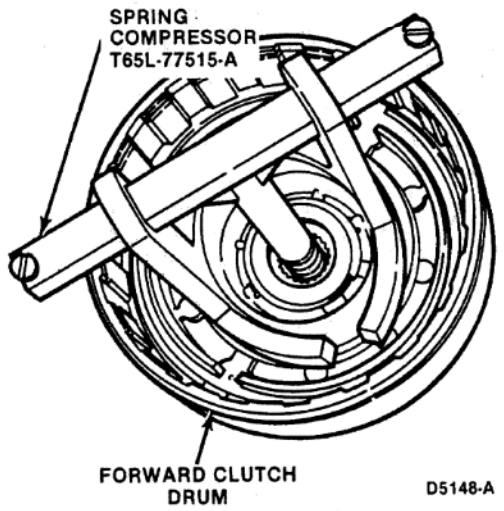


DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

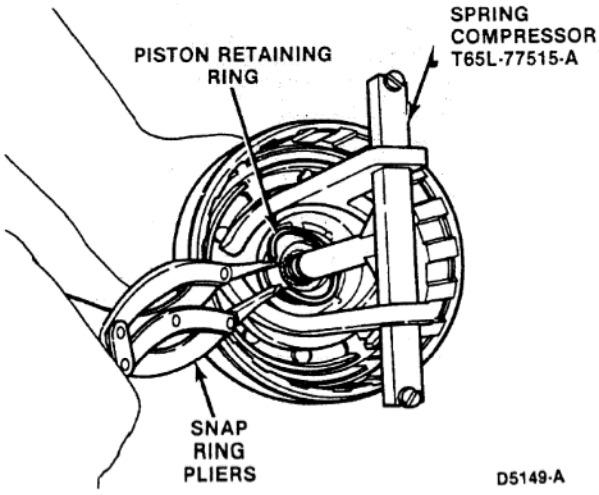
FORWARD CLUTCH

Disassembly (Continued)

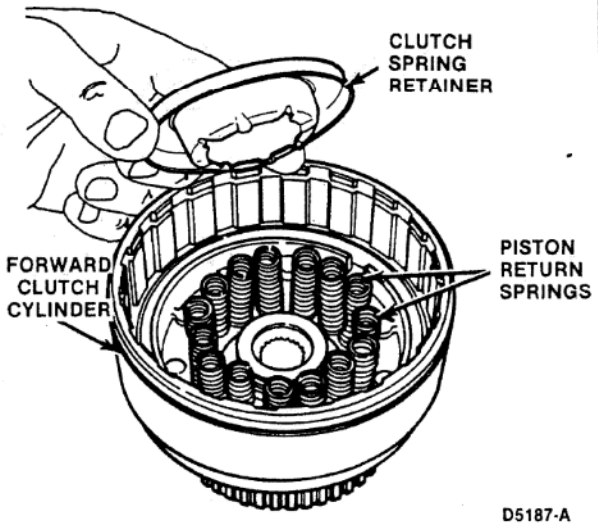
3. Using Clutch Spring Compressor T65L-77515-A, or equivalent, compress the piston return springs.



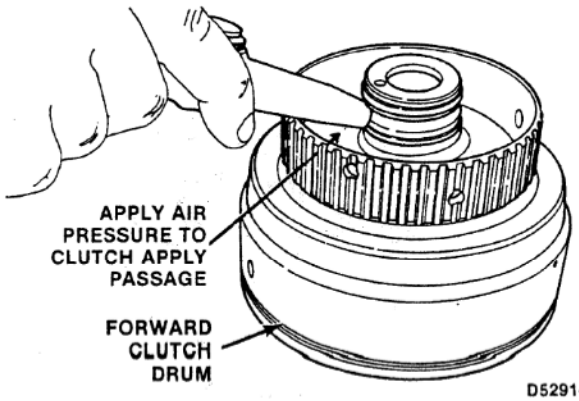
4. Remove the piston retaining ring using external snap ring pliers.



5. After removing the spring compressor, remove the spring retainer and piston return springs.



6. Remove the clutch piston. If the clutch piston is difficult to remove, apply air to the clutch apply passage in the clutch hub and remove the piston using air pressure.

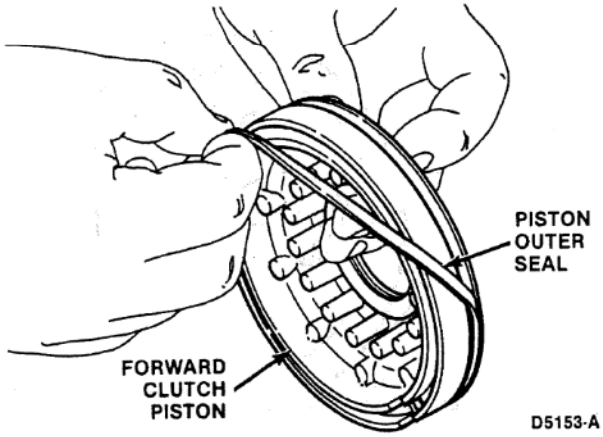


DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

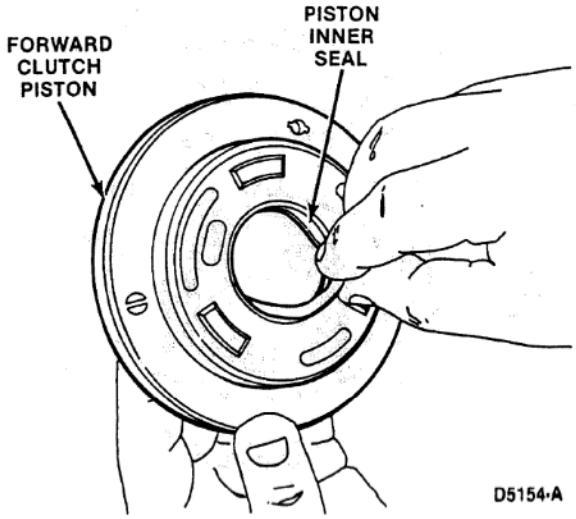
FORWARD CLUTCH

Disassembly (Continued)

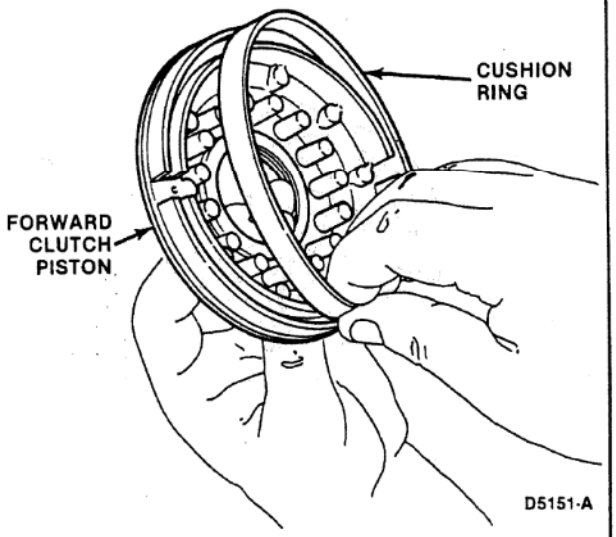
7. Remove the piston outer seal.



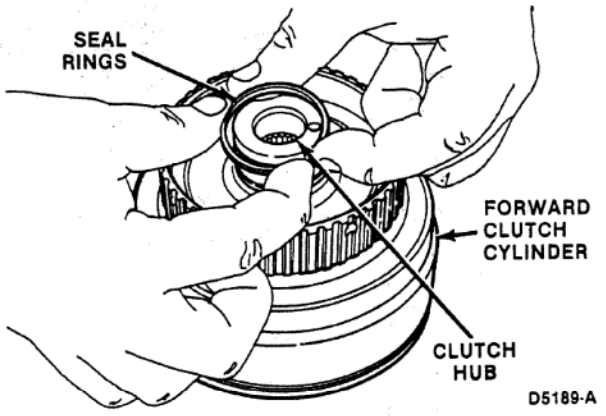
8. Remove the piston inner seal.



9. Remove the cushion ring from the piston.



10. Remove the seal rings from the clutch hub.

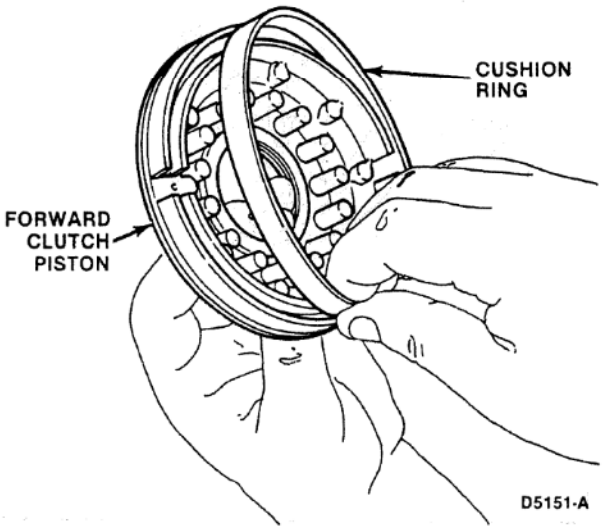


DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

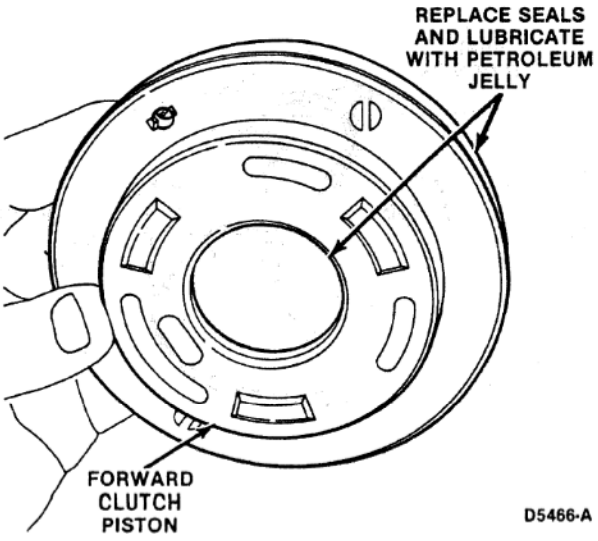
FORWARD CLUTCH

Assembly

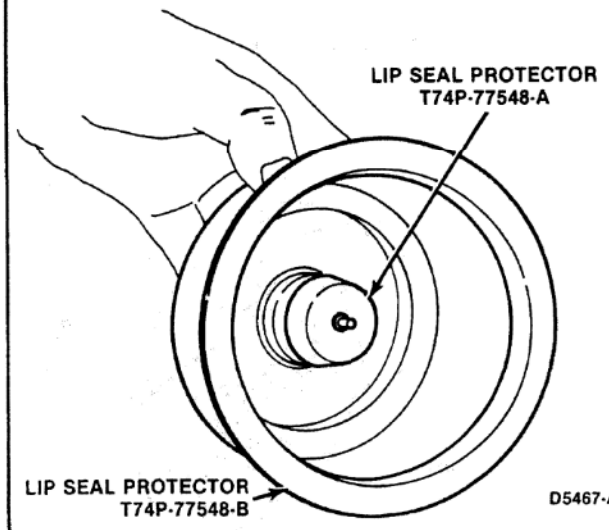
1. Install the cushion ring in the piston.



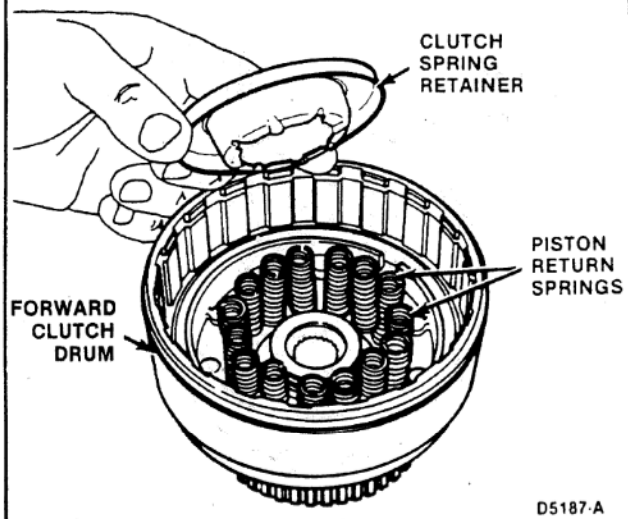
2. Install new seals on the piston and lubricate with petroleum jelly.



3. Install the piston in the clutch drum, using Lip Seal Protectors T74P-77548-A and T74P-77548-B, or equivalents.



4. Install the return springs and retainer on the piston.

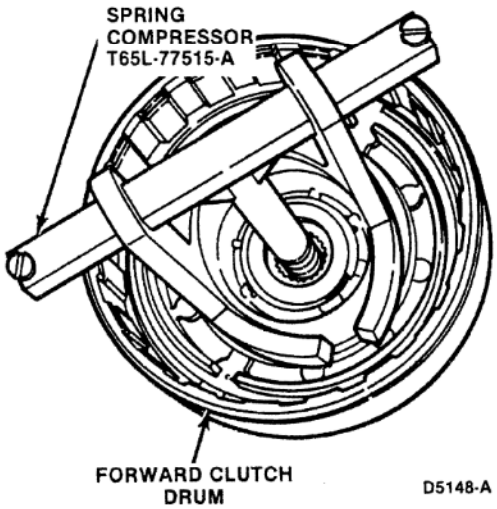


DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

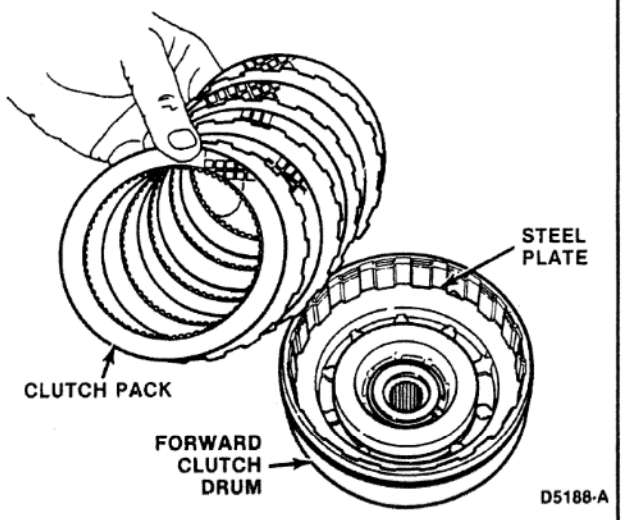
FORWARD CLUTCH

Assembly (Continued)

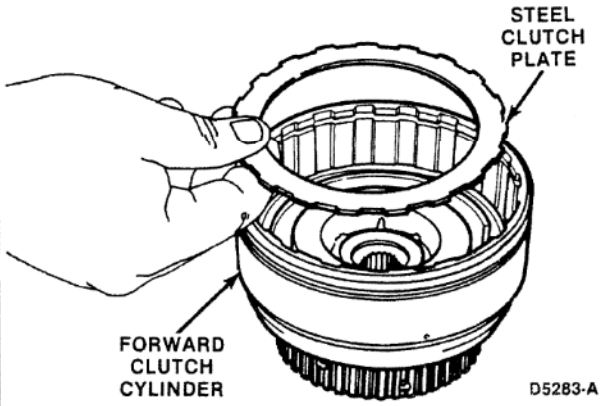
5. Compress the return springs, using Clutch Spring Compressor T65L-77515-A, or equivalent, and install the piston retaining ring.

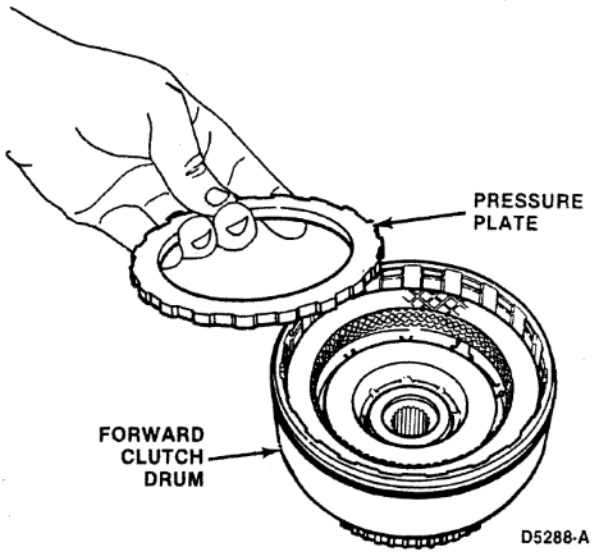


6. Install the clutch pack.



Starting with a steel plate, alternately install the friction and metallic plates. The last plate to be installed is the thick pressure plate.





NOTE: If new clutch plates are being installed, they must be soaked in transmission fluid for 30 minutes before the clutch pack can be assembled.

7. Install the clutch pack retaining ring.

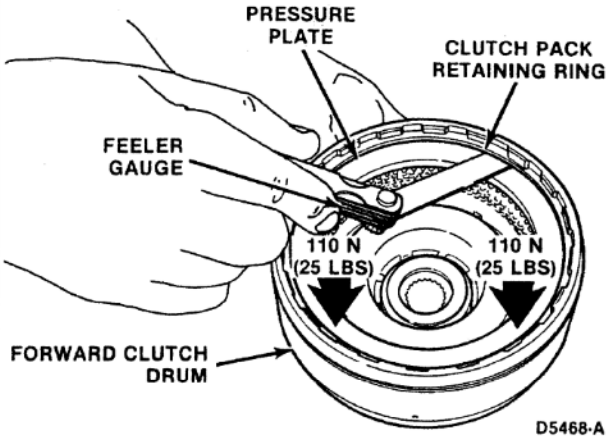
DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

FORWARD CLUTCH

Assembly (Continued)

8. Using a feeler gauge, check the clearance between the pressure plate and the clutch pack retaining ring.

   Press the clutch plates together, using at least 110N (25 lb.) of force and check the clearance in at least two positions.



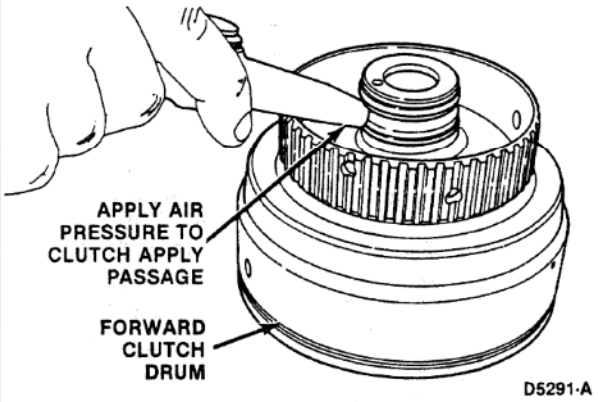
The clearance should measure 1.3 to 2.0 mm (.051 to .079 in.).

If the clearance is not within the specified service limits, selective retaining rings are available in the following thicknesses:

Part Number	mm	(in.)
E 860115-S	1.37	.0539
E 860116-S	1.73	.0681
E 860117-S	2.08	.0819
E 860118-S	2.44	.0961

If necessary, install a thicker or thinner retaining ring and recheck the clearance.

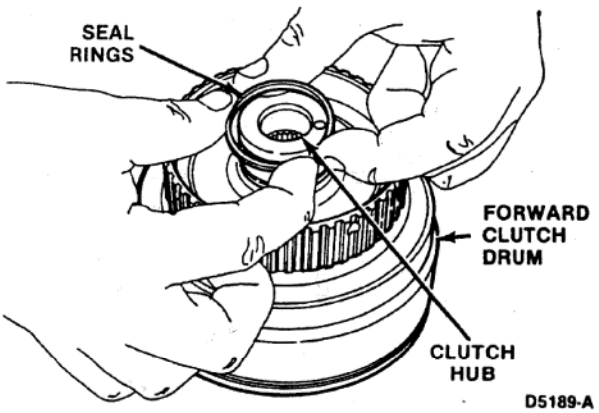
9. Check the clutch for proper operation, using air pressure.



The clutch should be heard and felt to apply smoothly and without leakage.

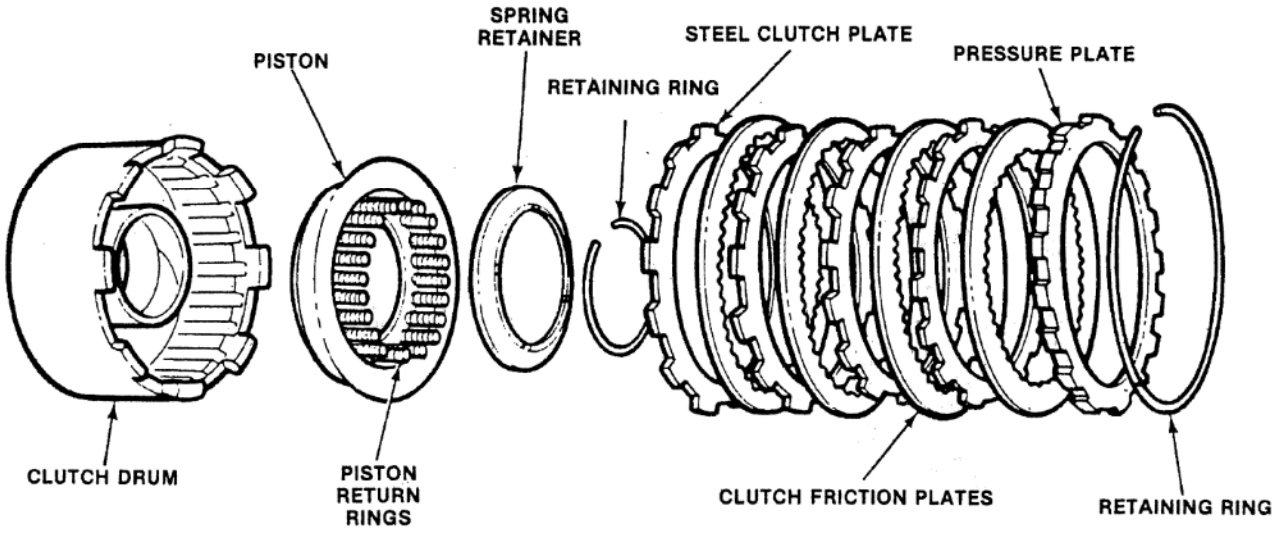
When the air pressure is removed, the piston should return to the released position.

10. Install the seal rings on the clutch hub.



DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

REVERSE/HIGH CLUTCH DISASSEMBLED VIEW

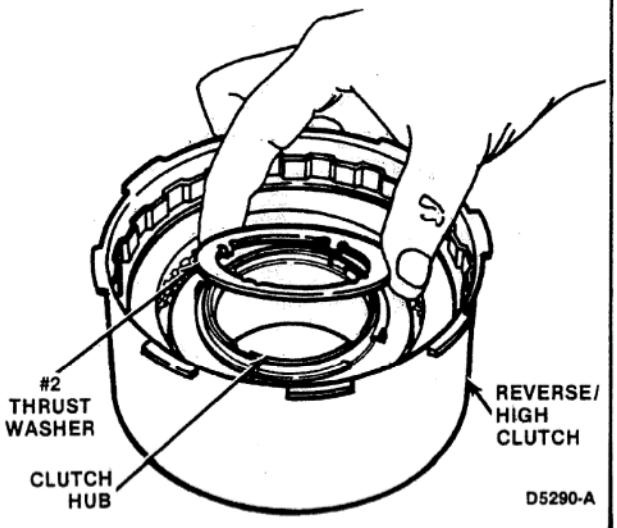


Disassembly

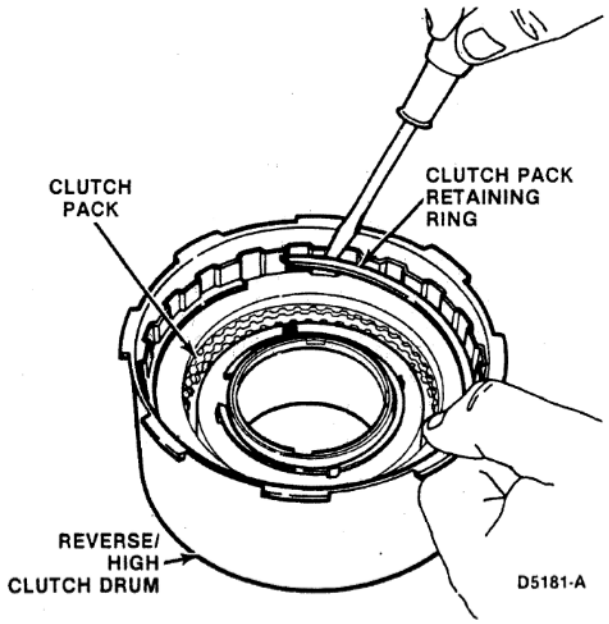
SPECIAL SERVICE TOOLS REQUIRED:

Spring Compressor	T65L-77515-A
Lip Seal Protector	T74P-77404-A

1. Remove the No. 2 thrust washer.



2. Remove the clutch pack retaining ring.

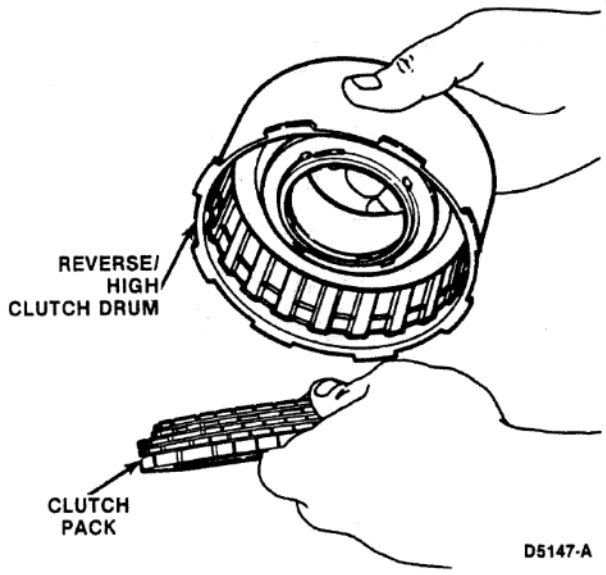


DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

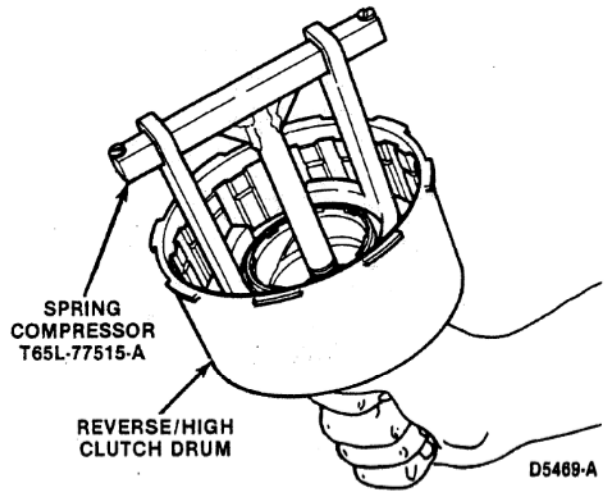
REVERSE/HIGH CLUTCH

Disassembly (Continued)

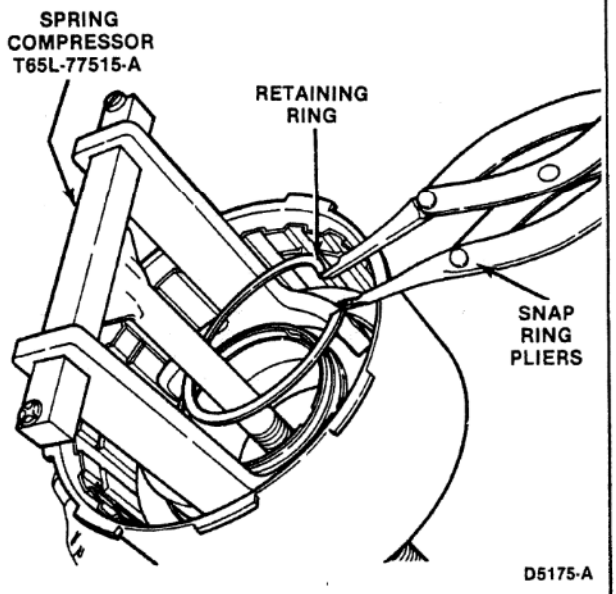
3. Remove the clutch pack from the clutch drum.



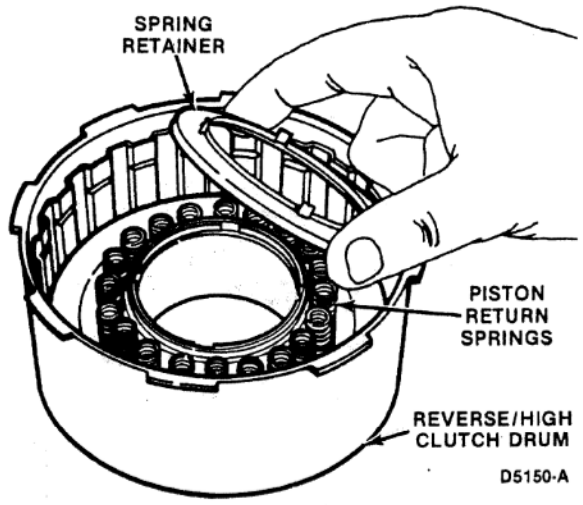
4. Using spring compressor T65L-77515-A, or equivalent, compress the piston return springs.



5. Remove the piston retaining ring, using external snap ring pliers.



6. After removing the spring compressor, remove the spring retainer.

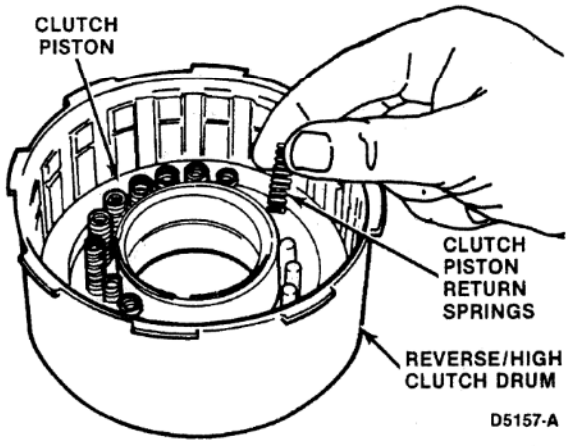


DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

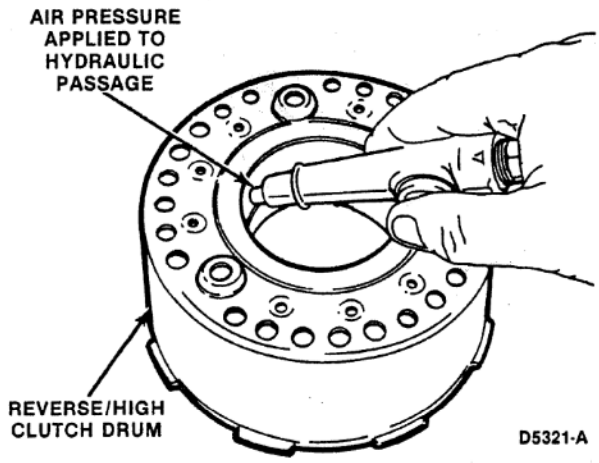
REVERSE/HIGH CLUTCH

Disassembly (Continued)

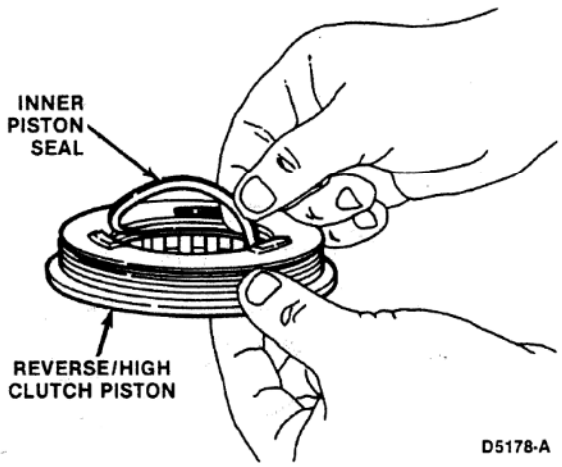
7. Remove the clutch return springs.

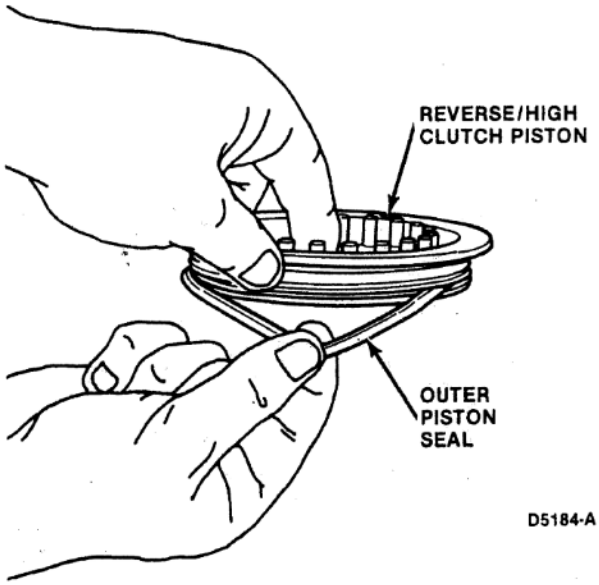


8. Remove the clutch piston. If the clutch piston is difficult to remove, position the pump housing on the clutch and remove the piston, using air pressure.



9. Remove the inner and outer seals from the piston.



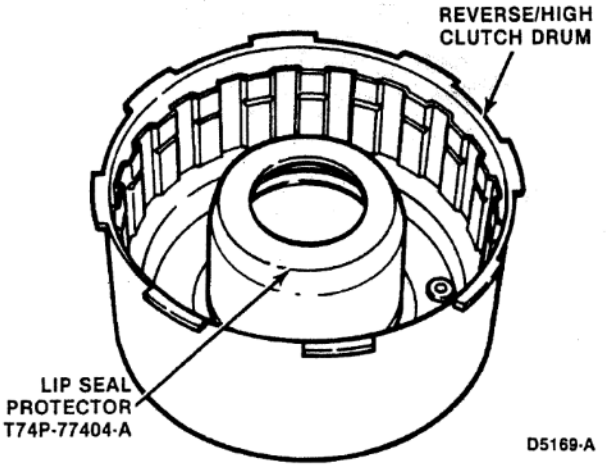


DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

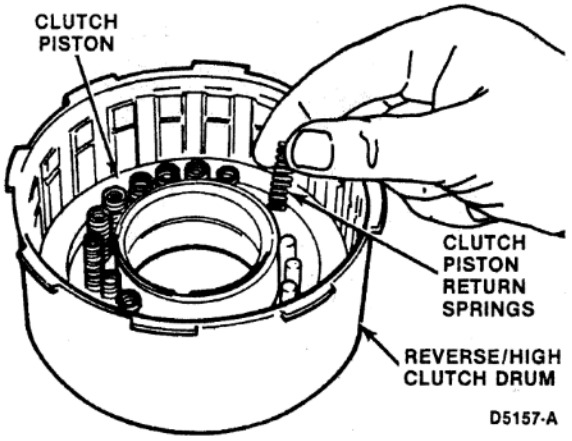
REVERSE/HIGH CLUTCH

Assembly

1. Install new seals on the piston and lubricate with petroleum jelly.
2. Install the piston in the clutch drum, using Lip Seal Protector T74P-77404-A, or equivalent.

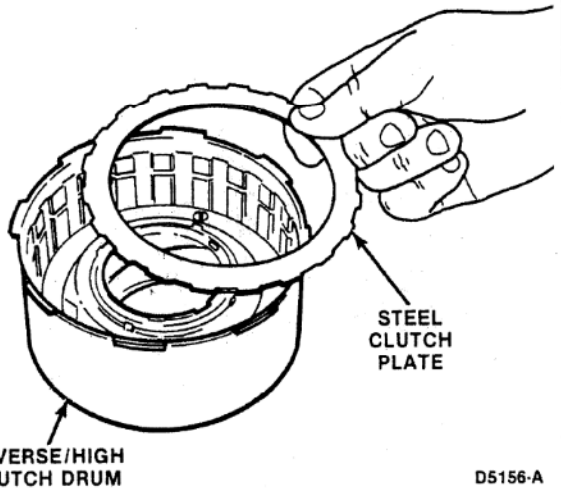


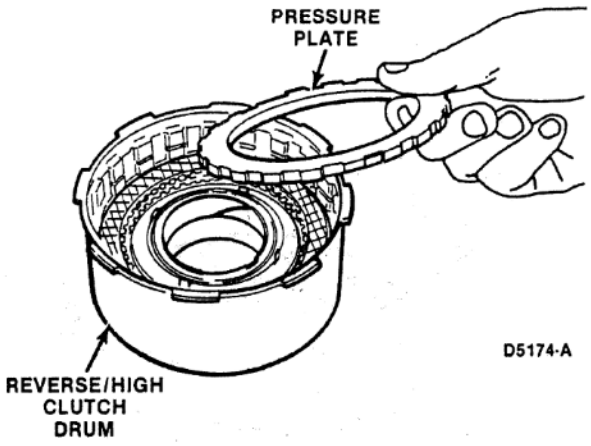
3. Install the return springs and retainer on the piston.



4. Compress the return springs, using Clutch Spring Compressor T65L-77515-A, or equivalent, and install the piston retaining ring.

5. Install the clutch pack. Starting with a steel plate, alternately install the friction and metallic plates. The last plate to be installed is the thick pressure plate.





NOTE: If new clutch plates are being installed, they must be soaked in transmission fluid for 30 minutes before the clutch pack can be assembled.

6. Install the clutch pack retaining ring.

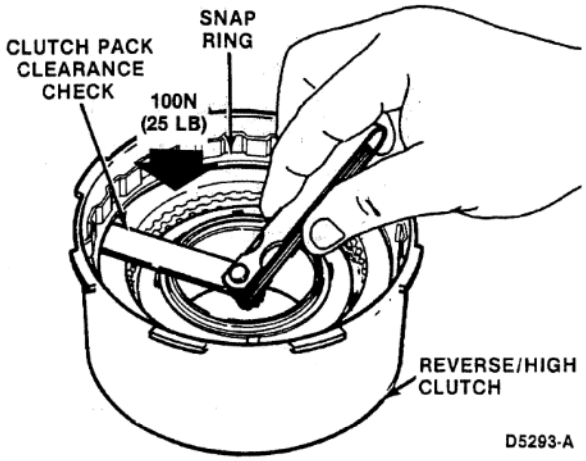
DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

REVERSE/HIGH CLUTCH

Assembly (Continued)

7. Using a feeler gauge, check the clearance between the pressure plate and the clutch pack retaining ring.

   Press the clutch pack together using at least 110N (25 lb.) of force and check the clearance in at least two positions.



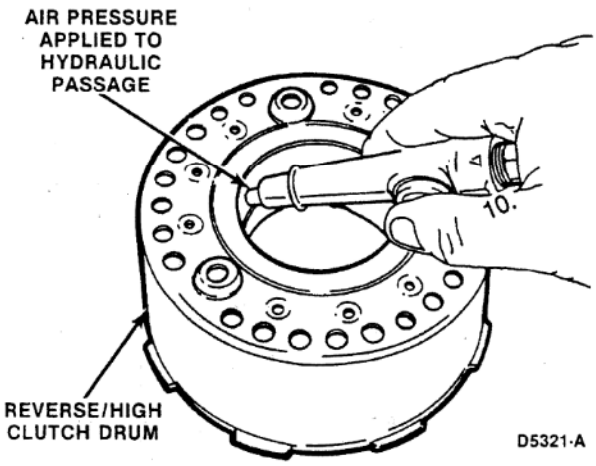
   The clearance should measure 1.4 to 2.1 mm (.054 to .082 in.).

   If the clearance is not within the specified service limits, selective retaining rings are available in the following thicknesses:

Part Number	mm	(in.)
E 860126-S	1.37	.0539
E 860127-S	1.73	.0681
E 860128-S	2.08	.0819
E 860129-S	2.44	.0961

   If necessary, install a thicker or thinner retaining ring and recheck the clearance.

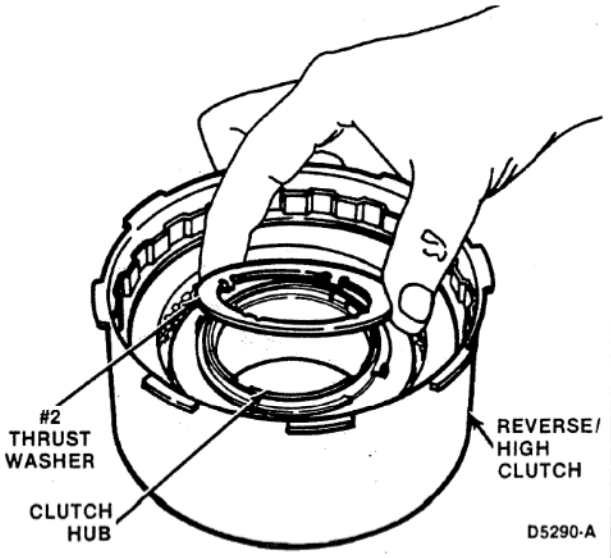
8. Check the clutch for proper operation, using air pressure.



   The clutch should be heard and felt to apply smoothly and without leakage.

   When the air pressure is removed, the piston should return to the released position.

9. Install the No. 2 thrust washer.

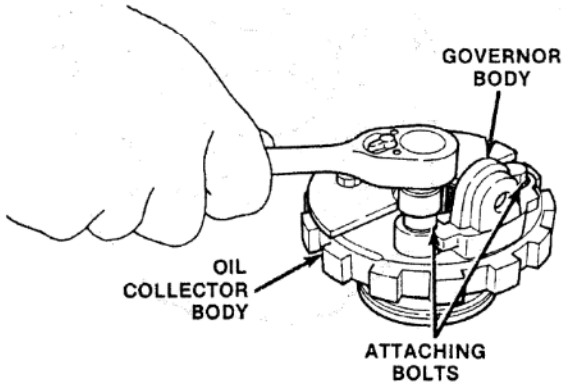


DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

GOVERNOR/OIL COLLECTOR BODY

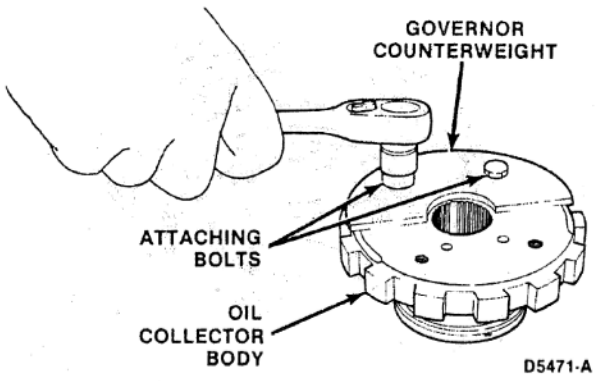
Disassembly

1. Remove the governor body attaching bolts and the governor body.

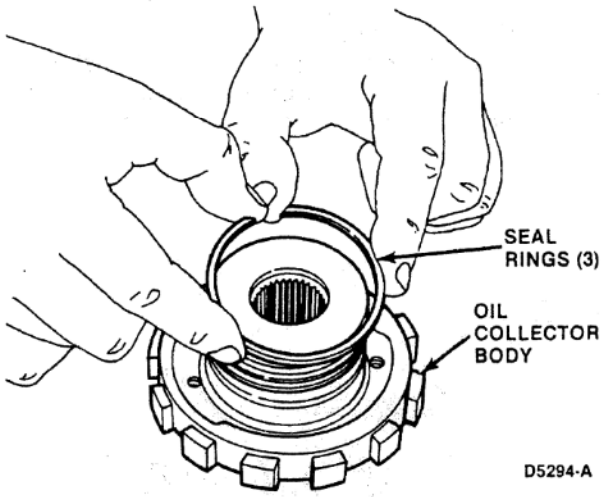


NOTE: The governor flyweight, spring, and valve were removed during transmission disassembly.

2. Remove the governor counterweight from the oil collection body.

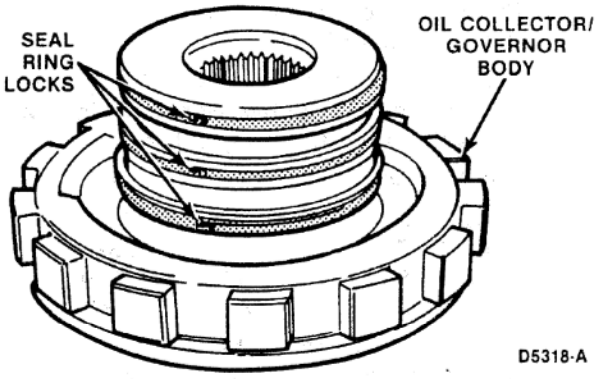


3. Remove the sealing rings from the oil collector body.



Assembly

1. Install the seal rings on the oil collector body.

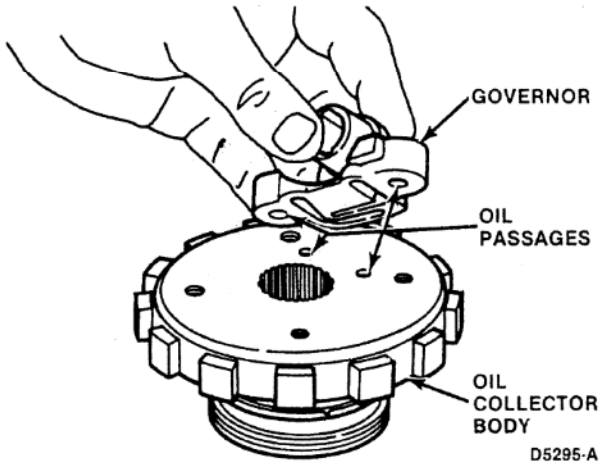


DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

GOVERNOR/OIL COLLECTOR BODY

Disassembly (Continued)

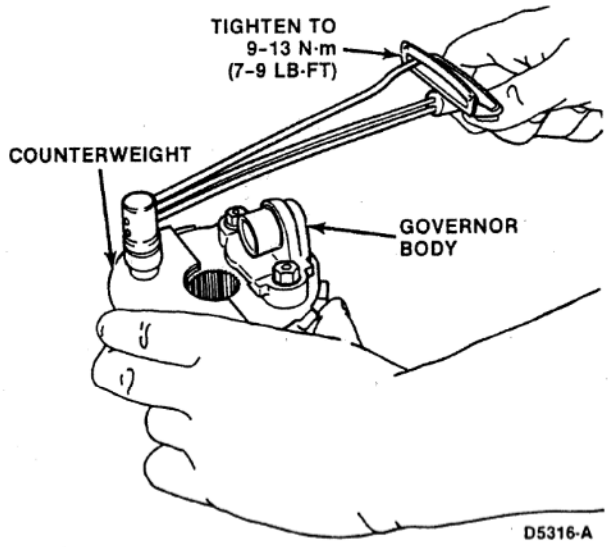
2. Position the governor on the oil collector body and align the oil passages. Install the attaching bolts and tighten to 9 to 13 N·m (7 to 9 lb-ft).



3. Install the governor counterweight on the oil collector body.

NOTE: Do not cover the fluid passages with the counterweight.

4. Tighten the attaching bolts to 9 to 13 N·m (7 to 9 lb-ft).



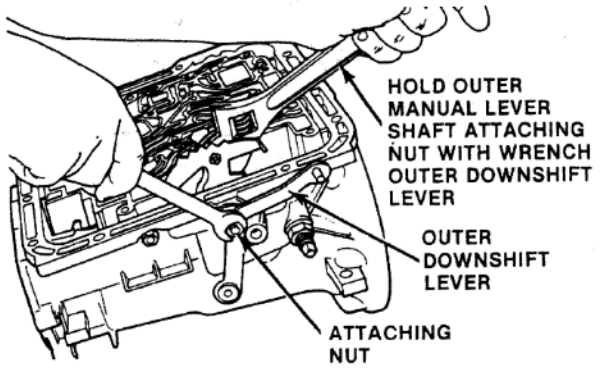
SHIFT LINKAGE

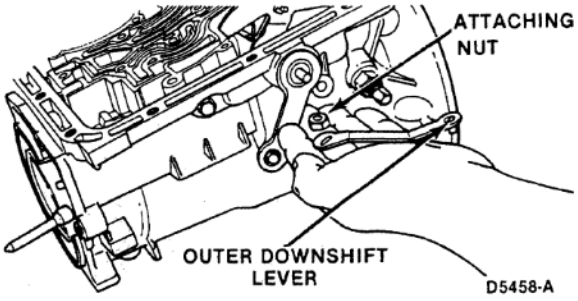
SPECIAL SERVICE TOOLS REQUIRED:

Seal Replacer	T74P-77498-A

Disassembly

1. Remove the attaching nut and the outer downshift lever.



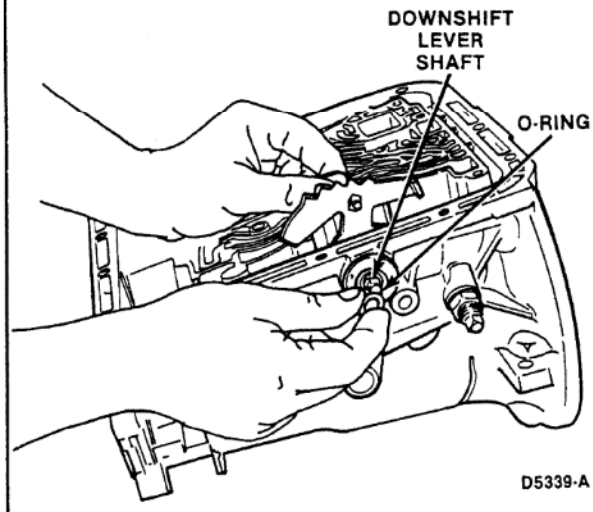


DISASSEMBLY AND ASSEMBLY

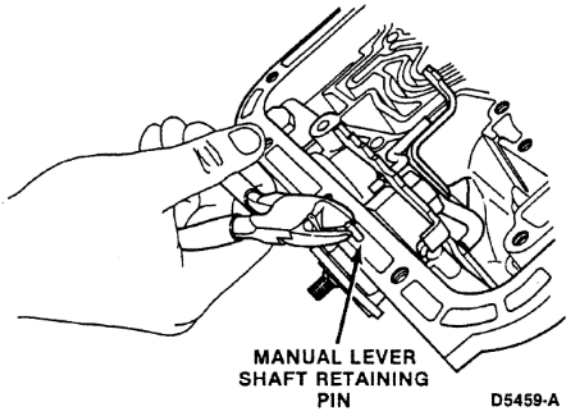
SHIFT LINKAGE

Disassembly (Continued)

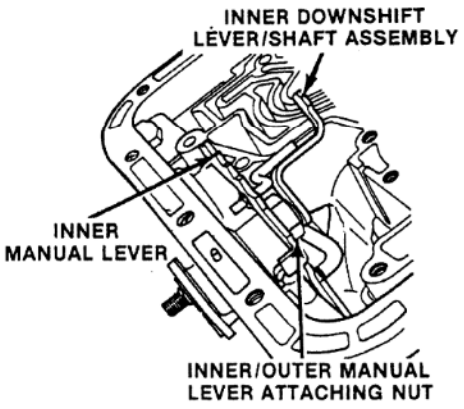
2. Remove the O-ring from the downshift lever shaft and discard.



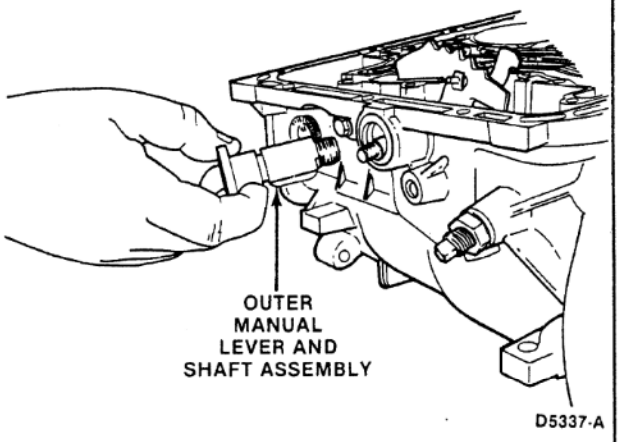
3. Remove the manual lever shaft retaining pin from the case.



4. Loosen the inner/outer manual lever attaching nut.



5. Remove the outer manual lever and shaft assembly.

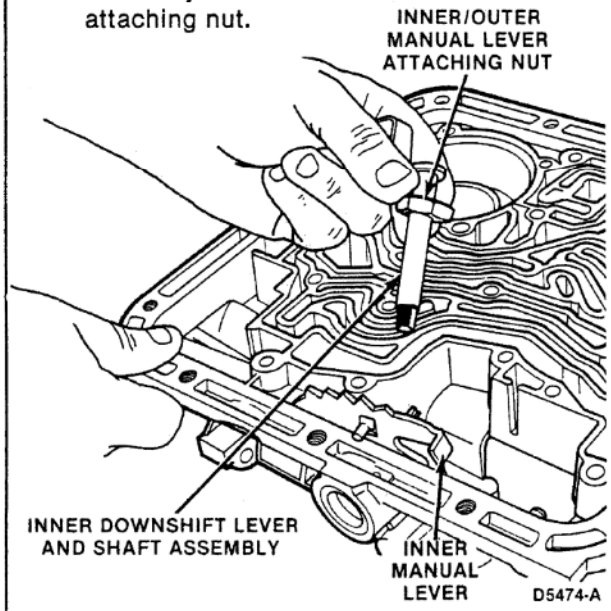


DISASSEMBLY AND ASSEMBLY

SHIFT LINKAGE

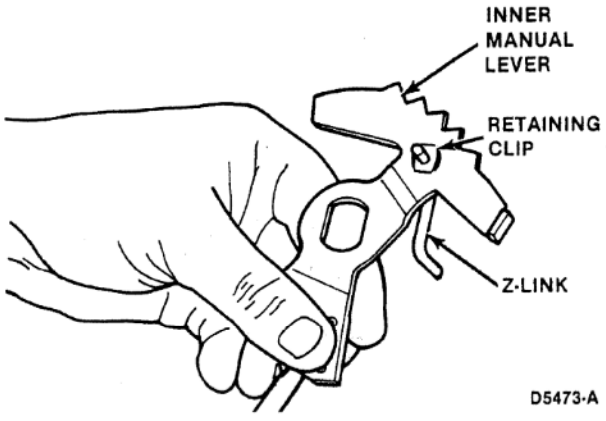
Disassembly (Continued)

6. Remove the inner downshift lever and shaft assembly and inner/outer manual lever attaching nut.



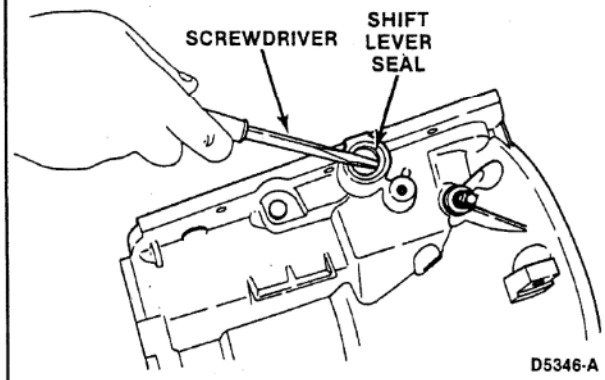
7. Remove the inner manual lever and parking pawl actuating rod assembly.
8. Disengage the parking pawl actuating rod from the inner manual lever.

9. Remove the retaining clip and separate the Z-link from the inner manual lever.



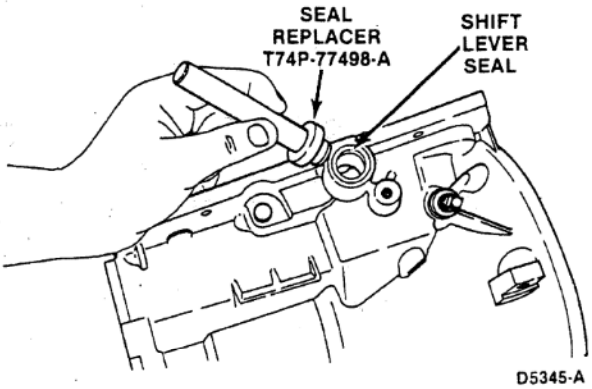
10. Remove the washer from the Z-link.

11. Remove the shift lever oil seal from the case, using a screwdriver.



Assembly

1. Install a new shift lever oil seal, using Seal Replacer T74P-77498-A, or equivalent.



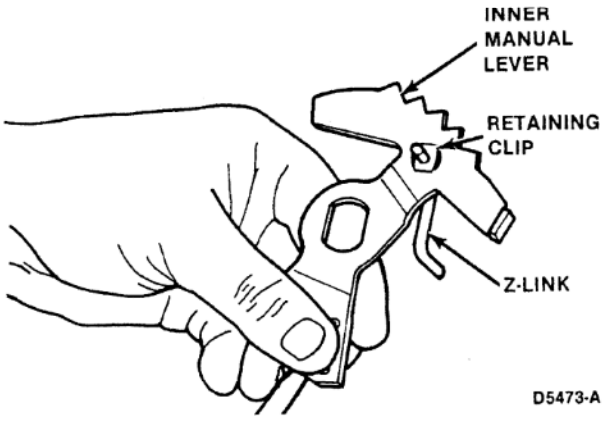
DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

SHIFT LINKAGE

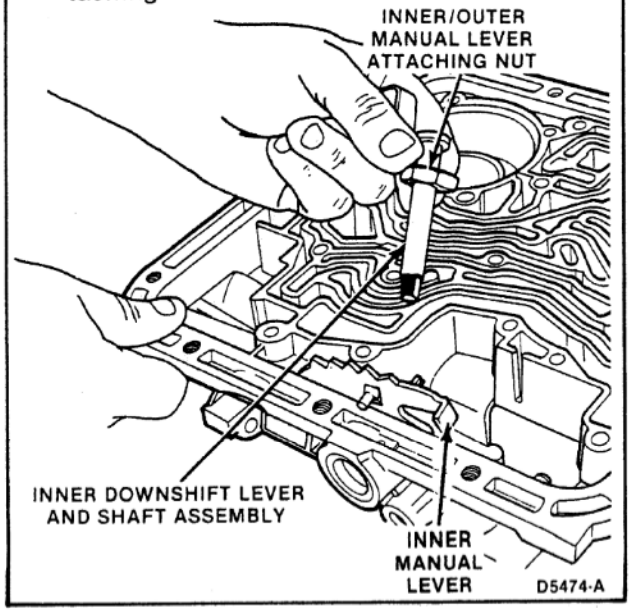
Assembly (Continued)

2. Position the washer and inner manual lever on the Z-link. Make sure the downshift lever return spring arm faces away from the link.

3. Install the Z-link retaining clip.

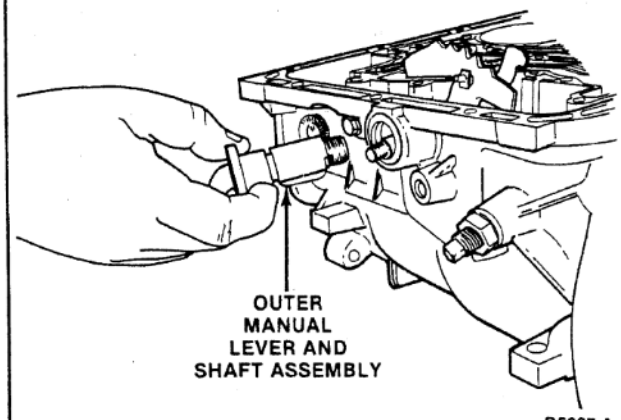


4. Position the inner manual lever and parking pawl actuating rod assembly in the case.
5. Install the inner downshift lever and shaft assembly, and inner/outer manual lever attaching nut.

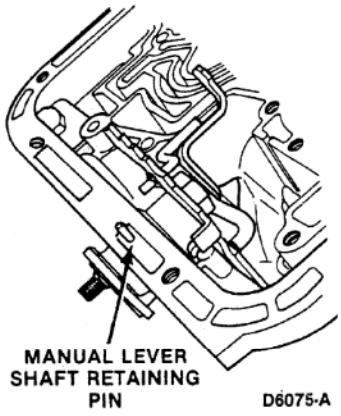


6. Install the outer manual lever and shaft assembly.

   As the shaft enters the case, position the throttle lever return spring, inner manual lever and attaching nut on the shaft.



7. Install the manual lever shaft retaining pin in the case and tighten the inner/outer manual lever attaching nut.

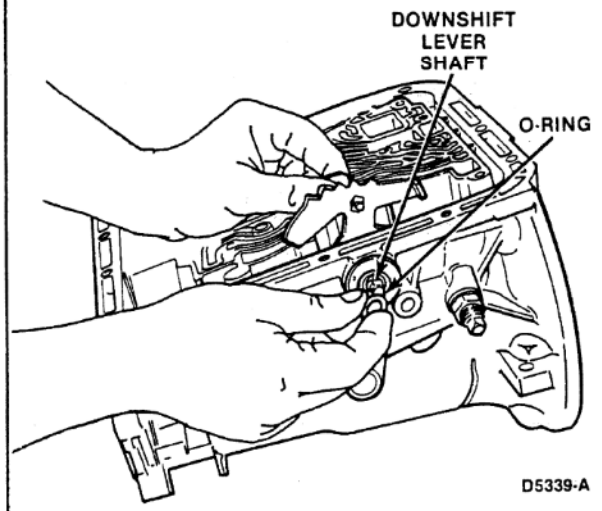


DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

SHIFT LINKAGE

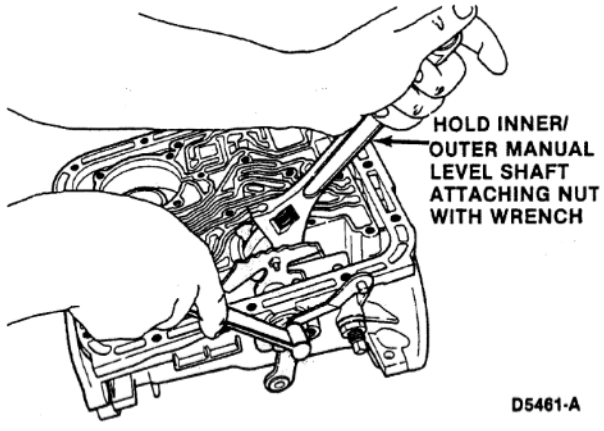
Assembly (Continued)

8. Install a new O-ring on the downshift lever shaft.



9. Install the outer downshift lever and the attaching nut.

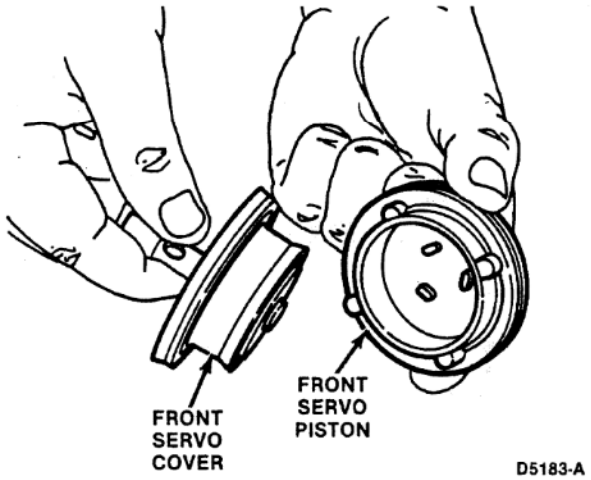
   Tighten the attaching nut to 10 to 14 N·m (7 to 11 lb-ft).



REVERSE SERVO

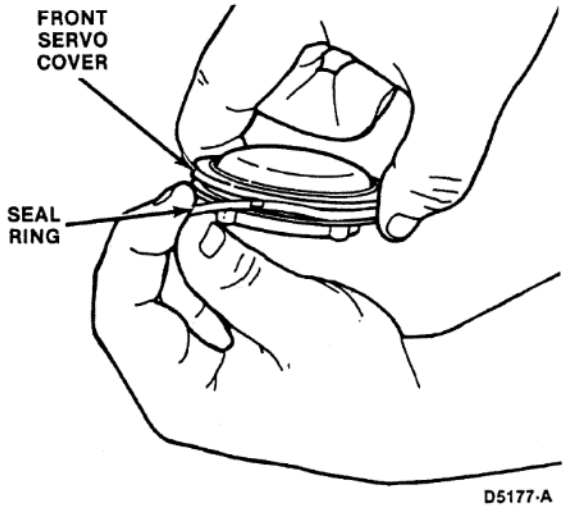
Disassembly and Assembly

1. Remove the servo piston from the servo cover.



2. Remove the seals from the servo piston.

3. Remove the seal from the servo cover.



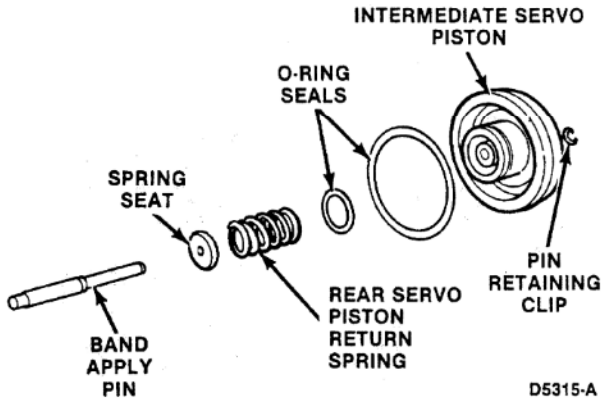
4. If necessary, the piston rod can be removed from the piston. Remove the piston-to-rod retaining ring and remove the rod from the piston.
5. To assemble the front servo, reverse Steps 1 through 4.

DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

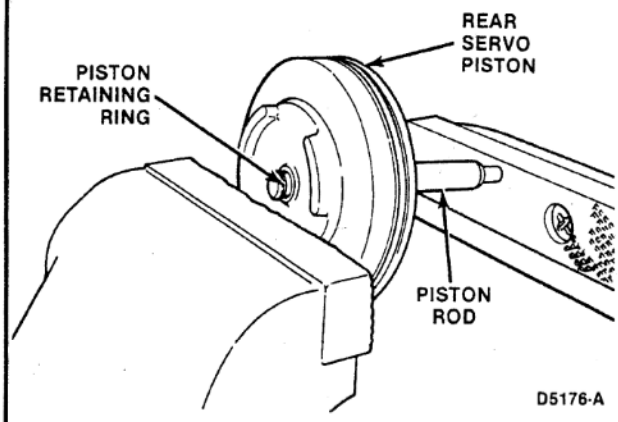
INTERMEDIATE SERVO

Disassembly and Assembly

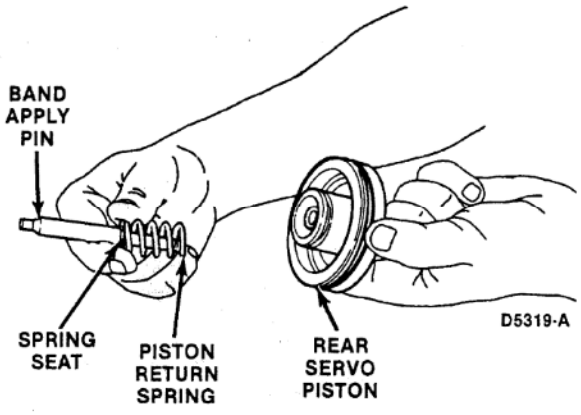
INTERMEDIATE SERVO DISASSEMBLED VIEW



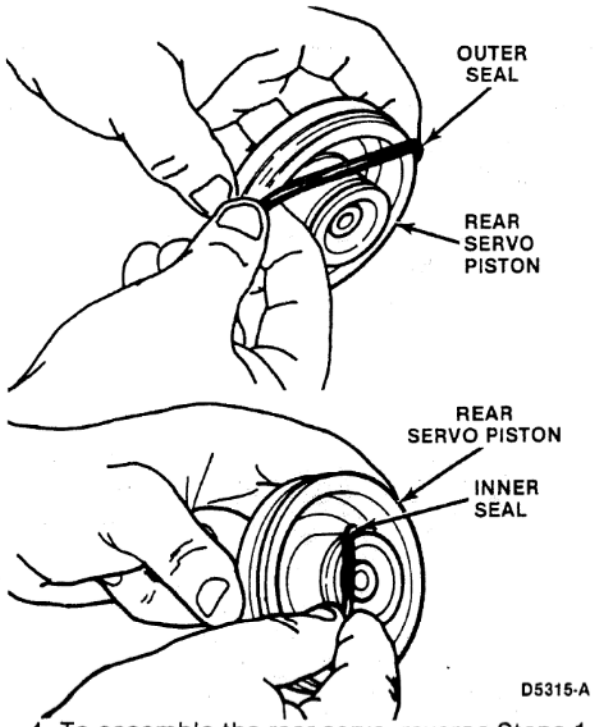
1. If necessary, the piston rod can be removed from the piston. With the piston clamped in a vise, remove the piston-to-rod retaining ring.



2. Remove the rod from the piston.



3. Remove the seals from the servo piston.



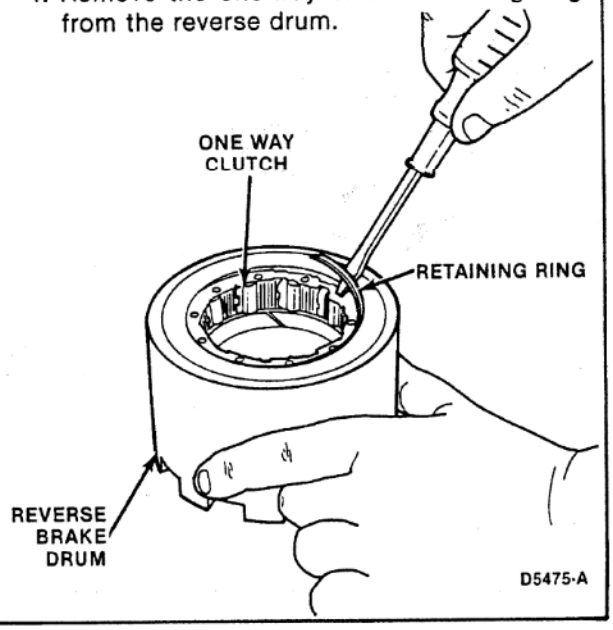
4. To assemble the rear servo, reverse Steps 1 through 3.

DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

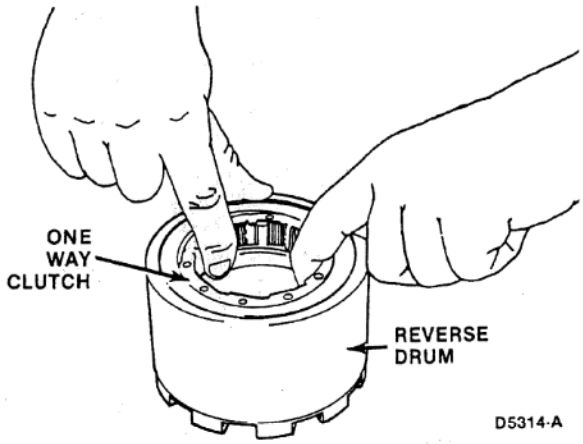
ONE-WAY CLUTCH

Disassembly

1. Remove the one-way clutch retaining ring from the reverse drum.

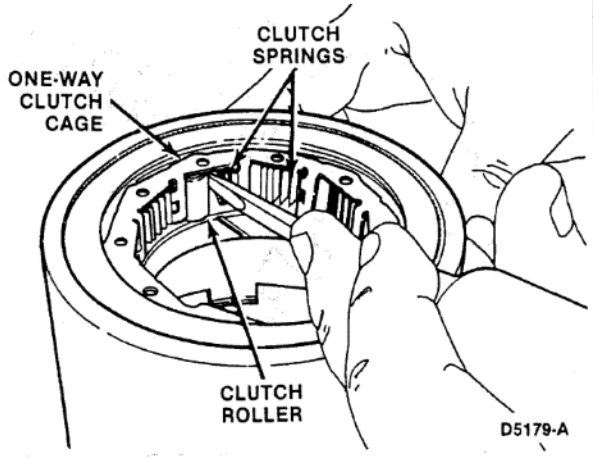


2. Remove the one-way clutch from the reverse drum as an assembly.



Assembly

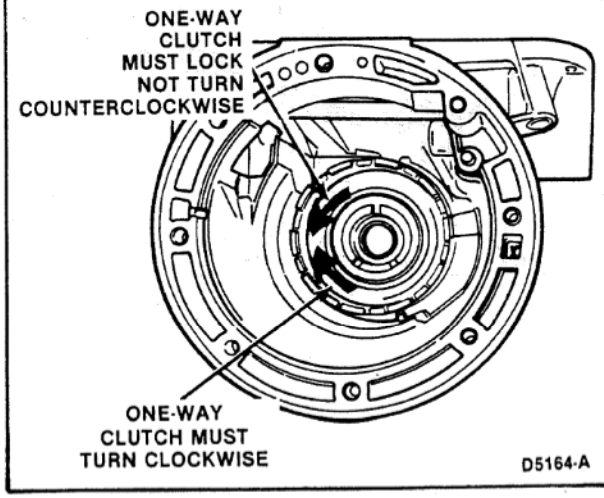
1. Install the roller springs in the one-way clutch cage.
2. Install the cage and spring assembly in the reverse brake drum.
3. Install the one-way clutch retaining ring.
4. Using a screwdriver, compress the springs and install the one-way clutch rollers.



After installing a roller, make sure it contacts the end of the spring.

5. Check the operation of the one-way clutch.

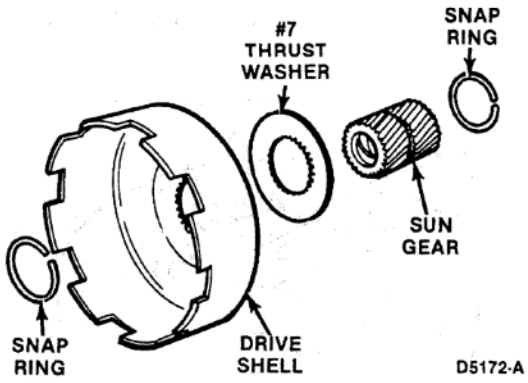
With the one-way clutch and drum assembly installed on the inner race located in the case, the drum should turn in a clockwise direction and lock in a counterclockwise direction.



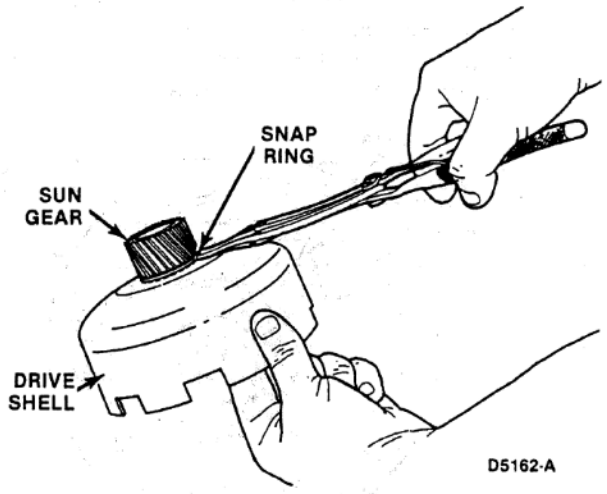
DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

DRIVE SHELL AND SUN GEAR

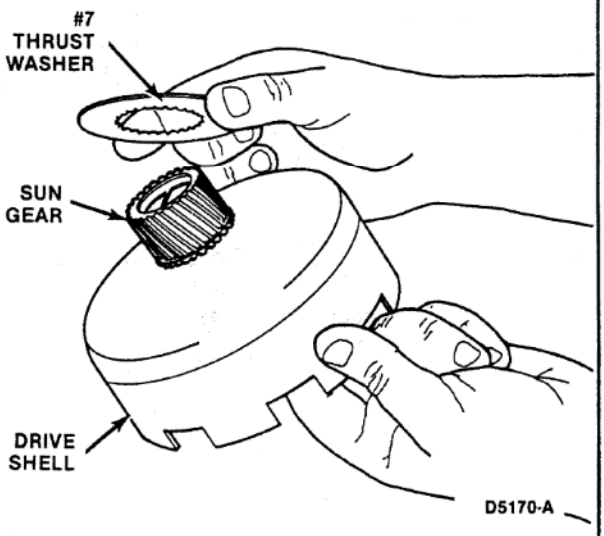
Disassembly and Assembly



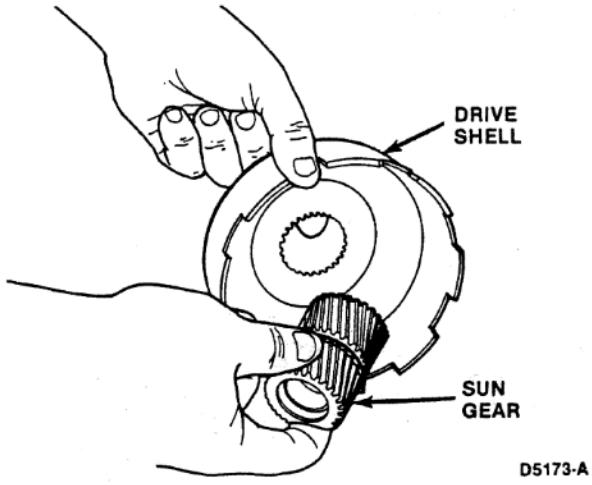
1. Remove the rear snap ring from the sun gear, using external snap ring pliers.



2. Remove the thrust washer (No. 7) from the drive shell.



3. Remove the sun gear from the drive shell.



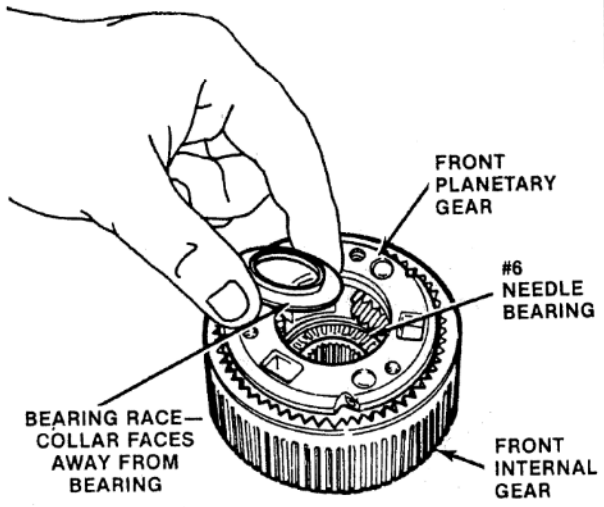
4. If necessary, remove the front snap ring from the sun gear, using external snap ring pliers.
5. To assemble the drive shell and sun gear, reverse Steps 1 through 4.

DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

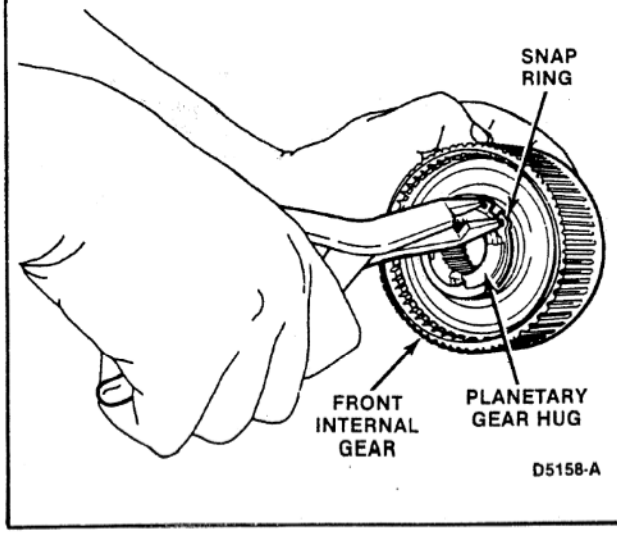
FRONT PLANETARY

Disassembly and Assembly

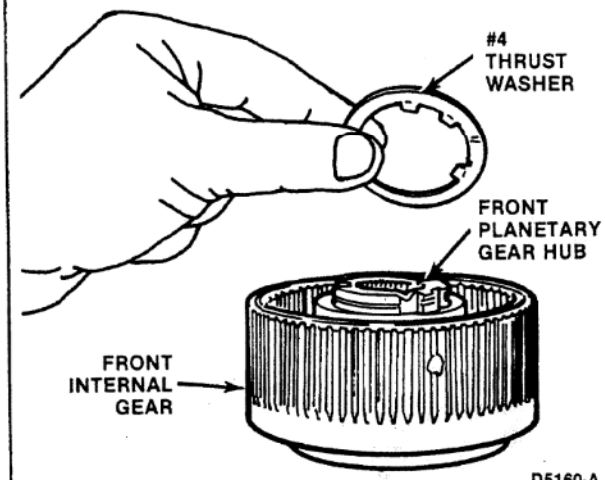
1. Remove the No. 6 needle bearing inner race.



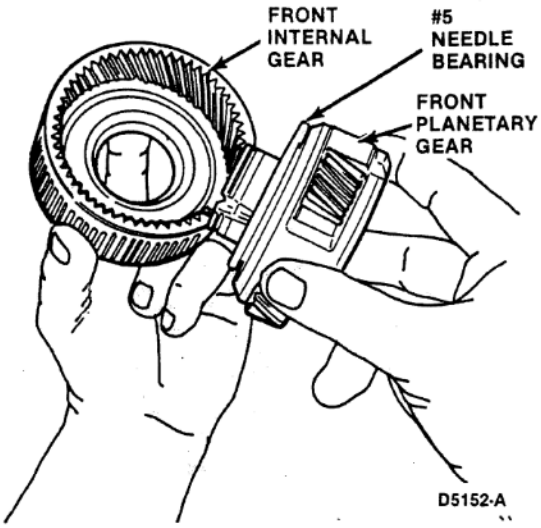
2. Remove the snap ring from the front planetary hub.



3. Remove the thrust washer (No. 4) from the front internal gear.



4. Remove the front planetary gear from the front internal gear.



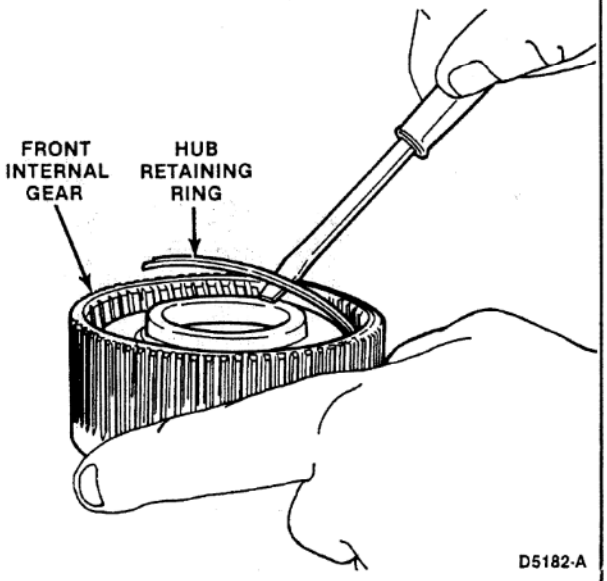
5. Remove the needle bearing (No. 5) from the front planetary carrier.

DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

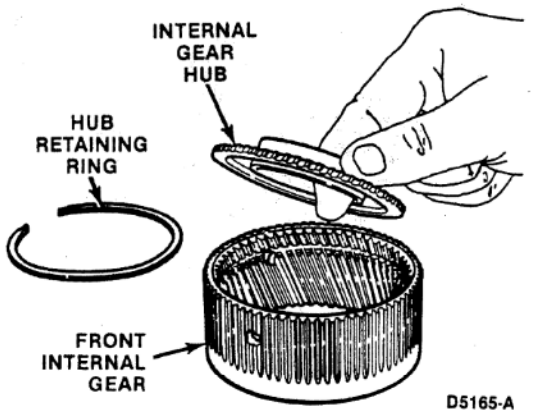
FRONT PLANETARY

Disassembly and Assembly (Continued)

6. Remove the hub retaining ring from the internal gear.



7. Separate the hub from the internal gear.

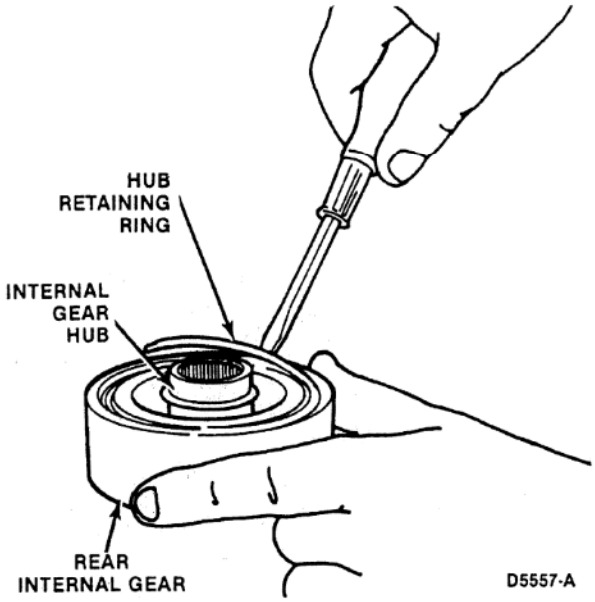


8. To assemble the front planetary, reverse Steps 1 through 7.

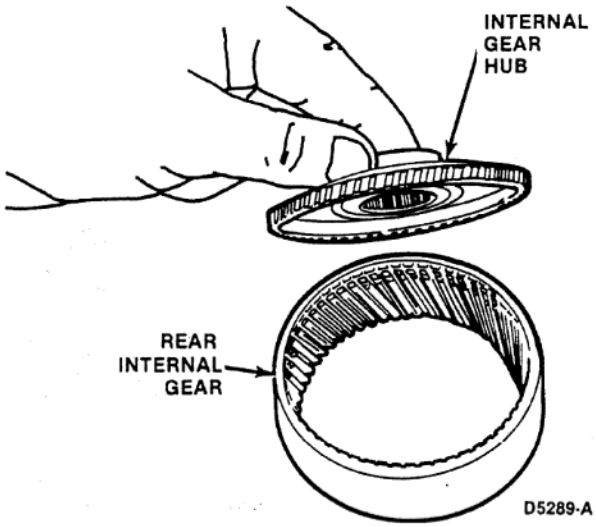
REAR PLANETARY

Disassembly and Assembly

1. Remove the hub retaining ring.



2. Separate the hub from the internal gear.



3. To assemble the internal gear and hub, reverse Steps 1 and 2.

DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

VALVE BODY

Disassembly and Assembly

During disassembly and assembly of the valve body, certain cleaning and inspection procedures must be followed. These general procedures are listed below:

- Use a clean work area, free of dirt and dust, when inspecting, cleaning, and installing the valves in the valve body.

A good practice is to use a piece of corrugated cardboard. It can be replaced to provide a clean fresh work surface for the valve body, and the ridges prevent the rolling of valves and springs.

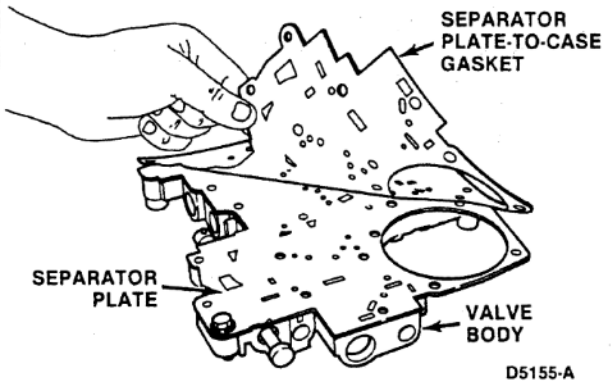
- Handle valve body components with clean hands and tools.
- Never clamp a valve body in a vise. Any slight distortion of the body will cause sticking valves or excessive leakage past a valve.
- Never drop a valve body. Sudden impacts will also cause distortion.
- When removing and installing valves or plugs, slide them in and out carefully. Do not use force to remove or install the valves.
- During disassembly organize the valves and springs according to bore and position in the bore. Do not interchange springs even though springs may be the same color and similar in size.
- Since many valve failures are caused initially by dirt or other foreign matter that prevents proper valve function, a thorough cleaning of all components with clean solvent is very important.
- After cleaning, blow dry each component with moisture-free compressed air.
- Use a penlight to inspect the valve body bores for scores, burrs, scratches, and pits. Make sure all metering holes in the separator plate and valve body are open.
- Inspect each valve and plug for free movement in its valve body bore. When bores, valves, and plugs are clean and dry, the valves and plugs must fall from their own weight into the valve body bore.
- Inspect all valves and plugs for burrs, nicks, and scores. Slight irregularities can be removed, using crocus cloth. Do not remove the sharp edges on the valve lands. These sharp edges perform a cleaning action which prevents dirt from lodging between the valve and the bore.
- Inspect each spring for distortion or collapsed coil.
- During assembly, lubricate each valve and bore with clean automatic transmission oil.
- If shop towels are used during cleaning operation, make sure they are lint-free. Small particles of lint can wedge between a valve and the valve bore, causing the valve to stick.

DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

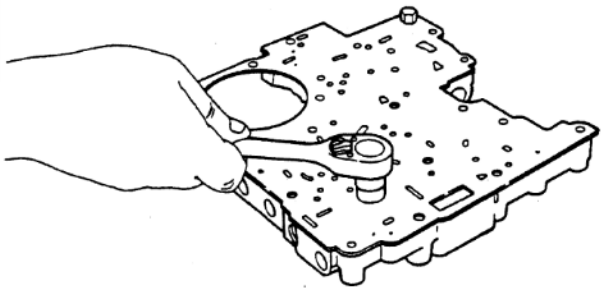
VALVE BODY

Disassembly and Assembly (Continued)

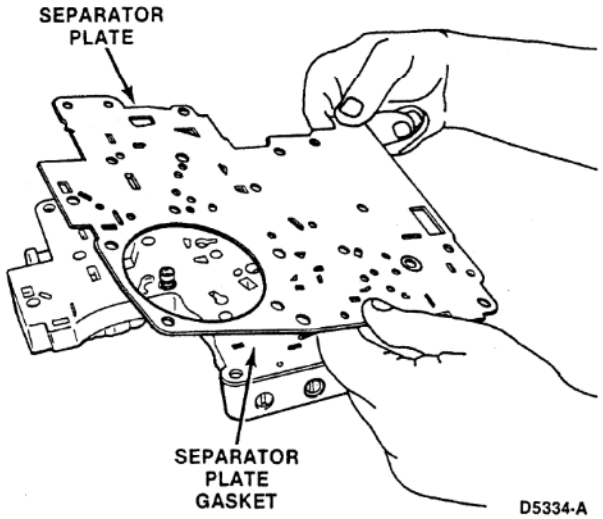
1. Remove the separator plate-to-case gasket.



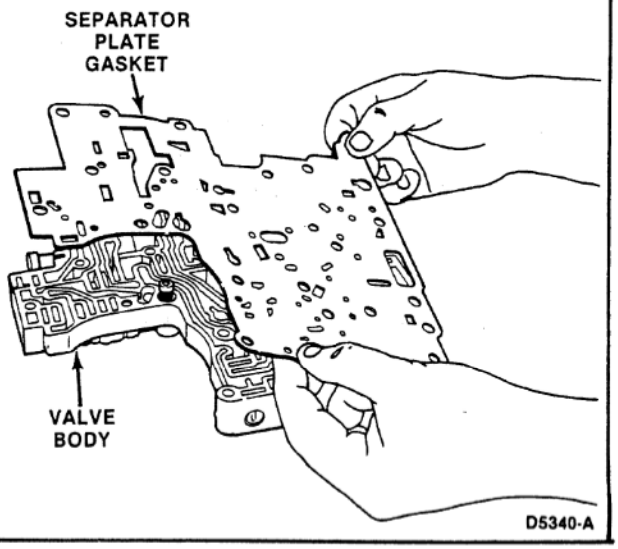
2. Remove the separator plate attaching bolts.



3. Remove the separator plate.



4. Remove the separator plate-to-valve body gasket.



DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

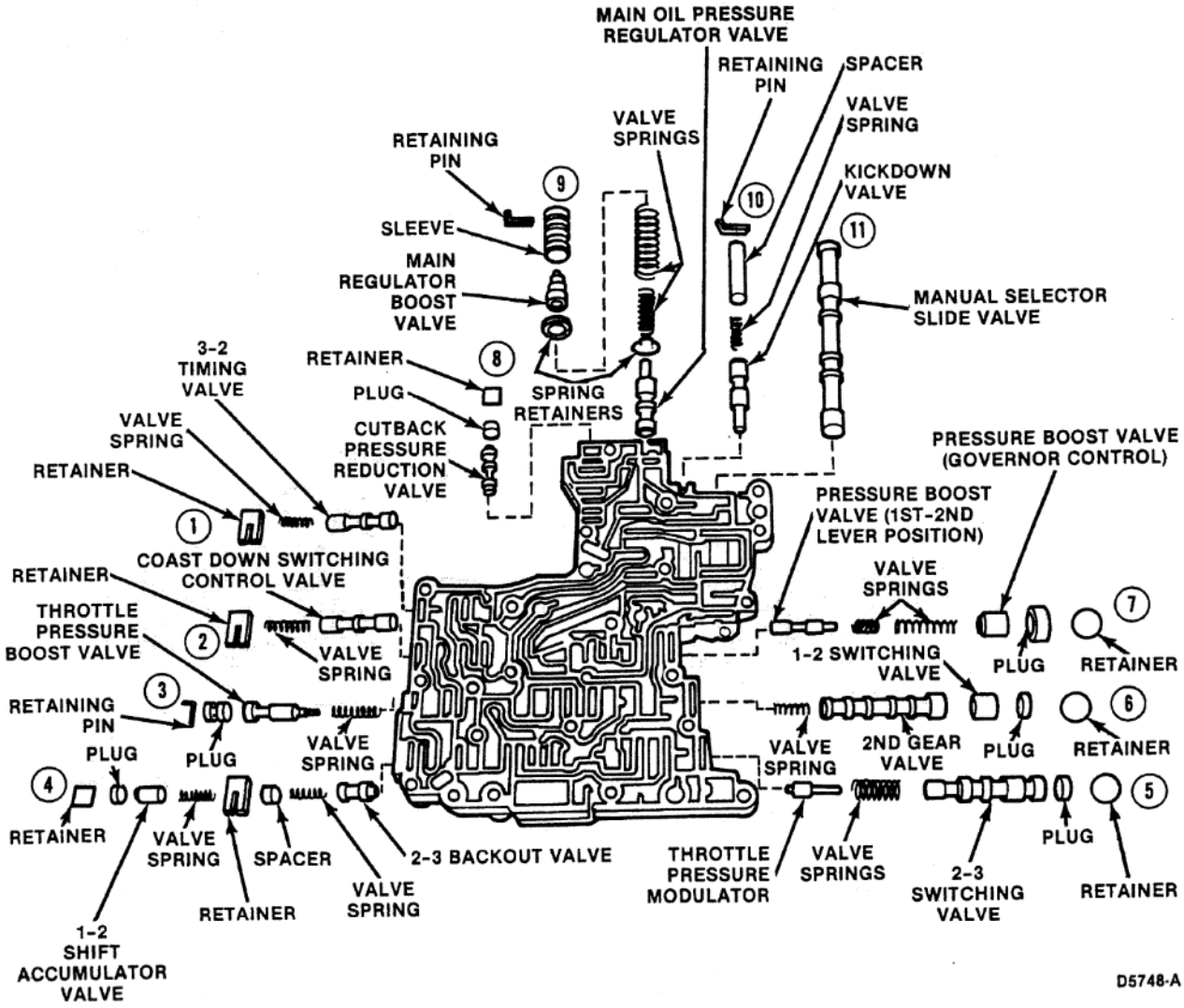
VALVE BODY

Disassembly and Assembly (Continued)

5. Remove the check balls, relief valves, and check valve.
6. The following procedural steps detail the removal and installation of the individual valves. Each valve body bore has been assigned a reference number on the disassembled view. The illustrations have been assigned a corresponding reference number.

Each set of illustrations contains the views necessary to remove and install the components contained in a particular valve body bore.

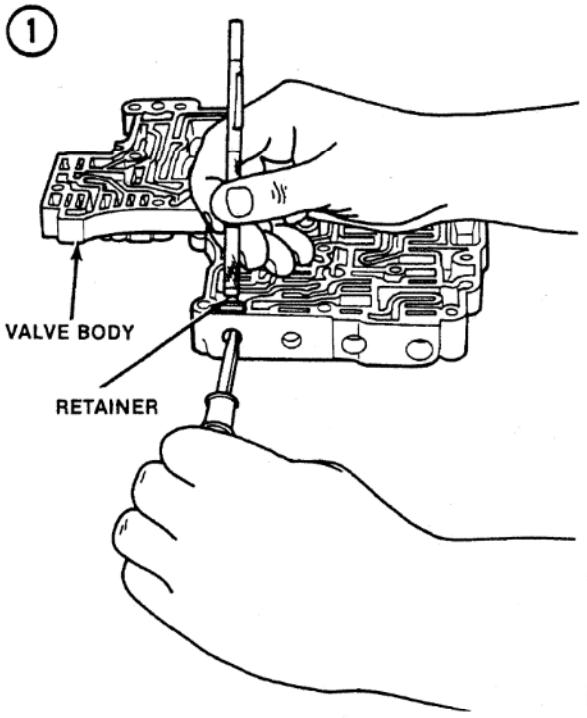
NOTE: Refer to Specifications for the dimensions required to fabricate a valve spring compressor tool. This tool will be very useful when installing those springs retained by a flat plate.

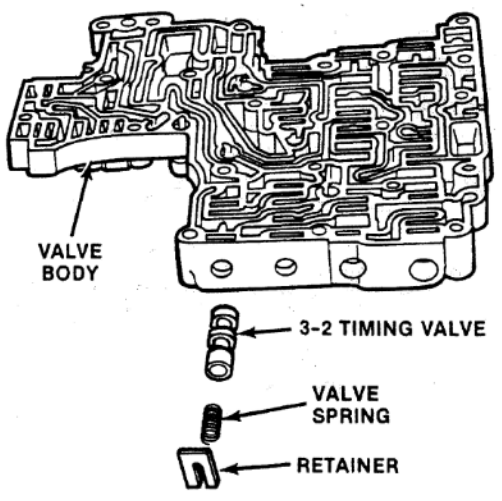


DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

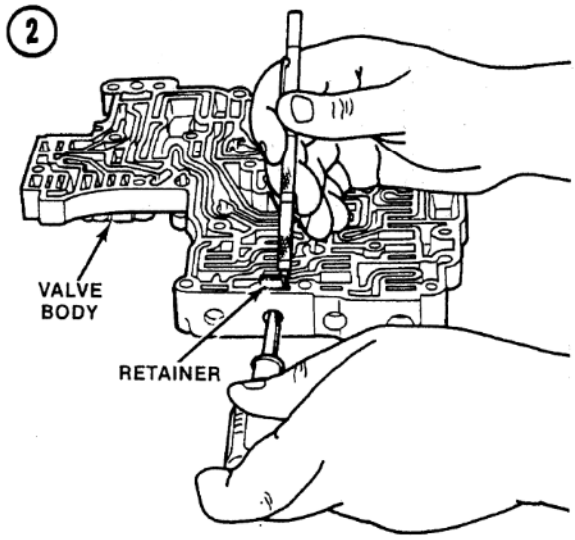
VALVE BODY

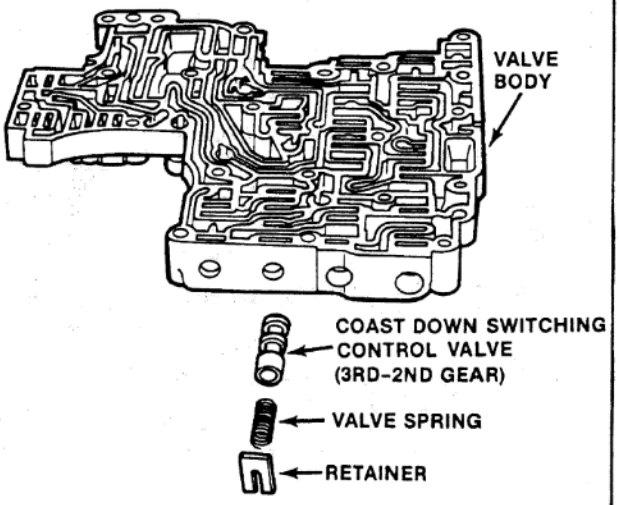
Disassembly and Assembly (Continued)





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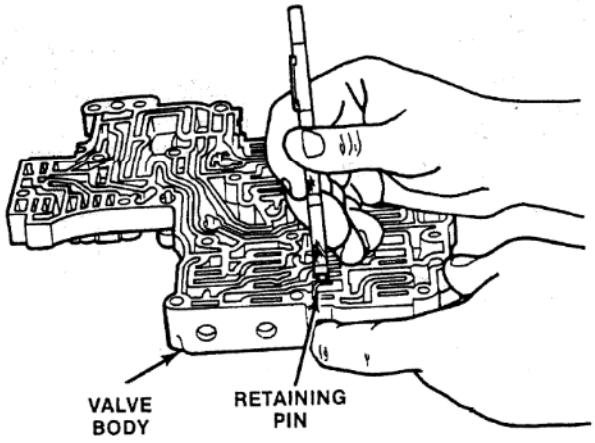
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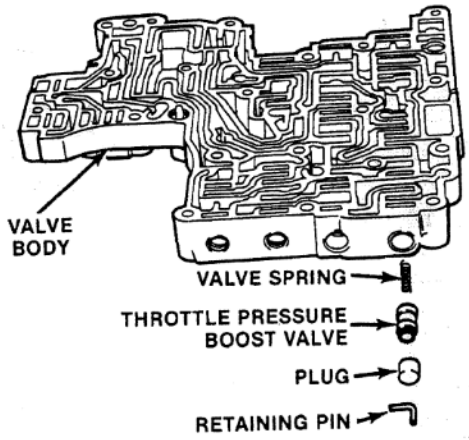
DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

VALVE BODY

Disassembly and Assembly (Continued)

(3)



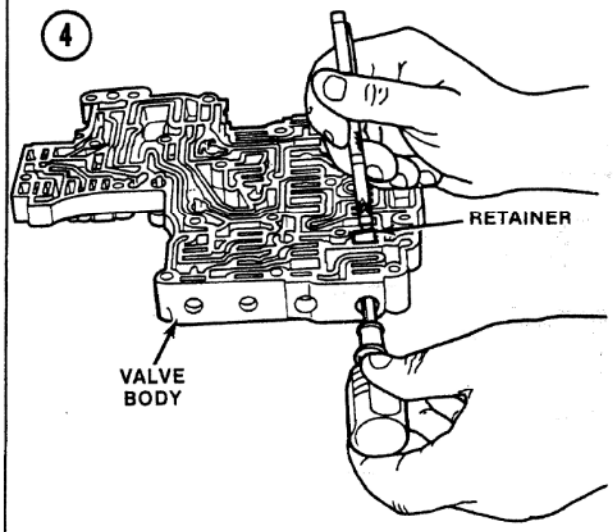


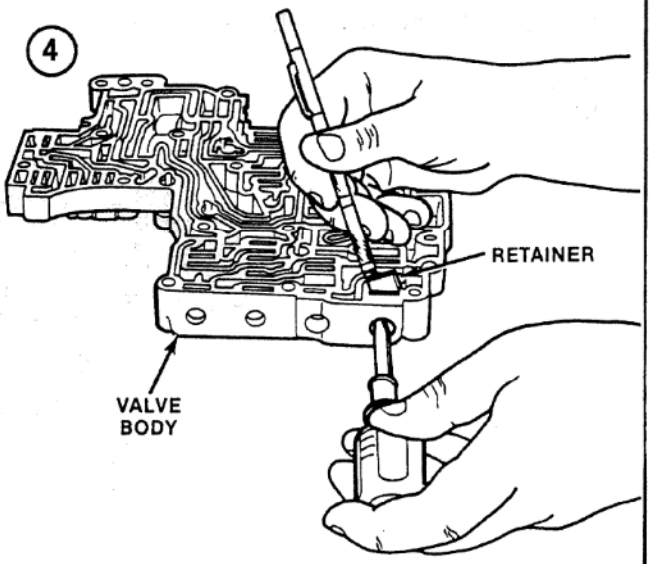
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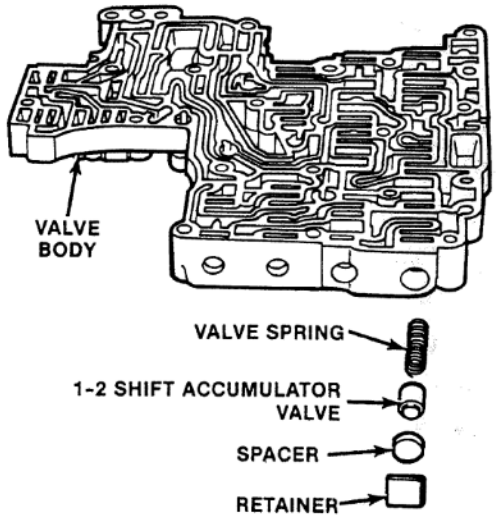
DISSASEMBLY AND ASSEMBLY/SUBASSEMBLIES

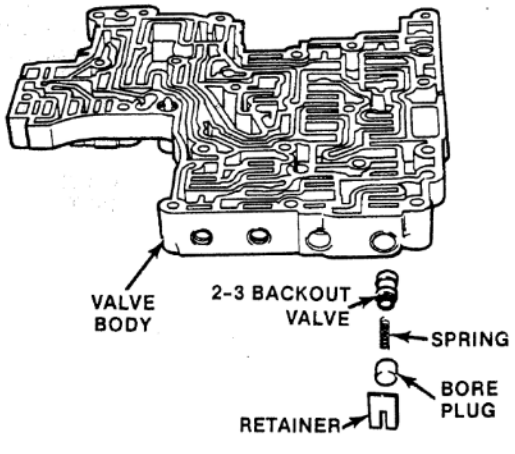
VALVE BODY

Disassembly and Assembly (Continued)









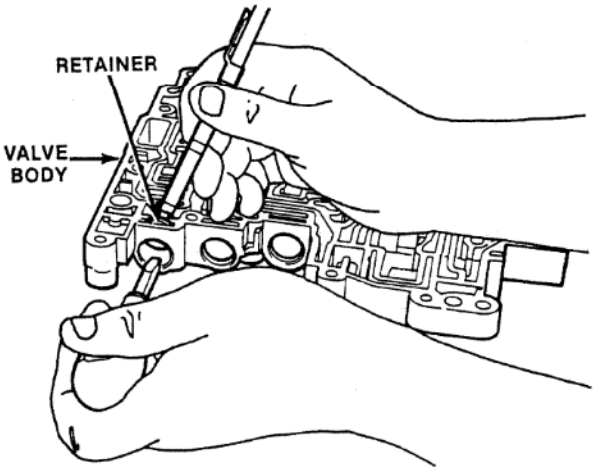
D5752-A

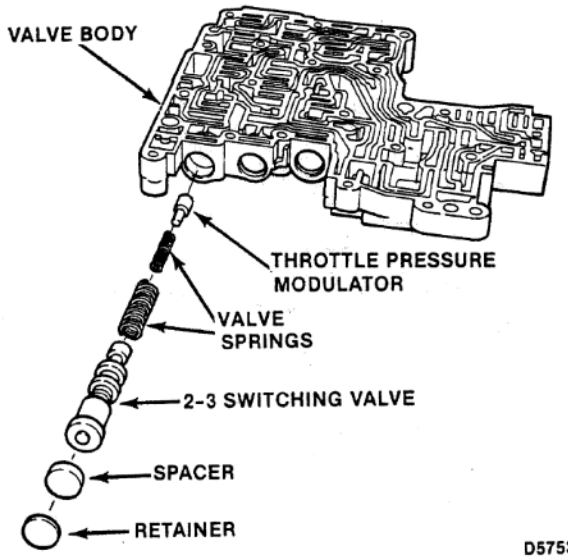
DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

VALVE BODY

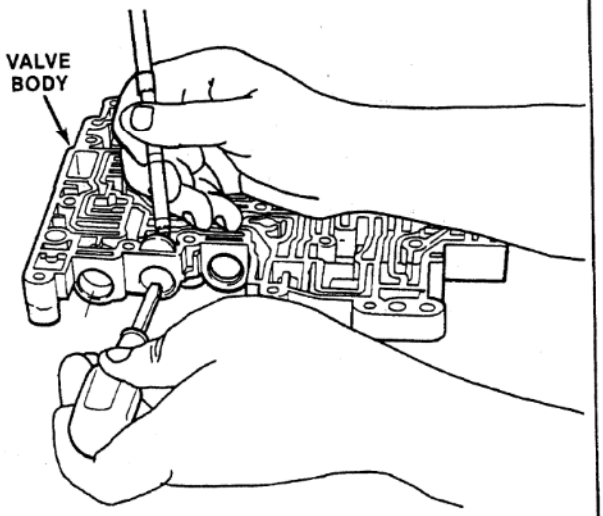
Disassembly and Assembly (Continued)

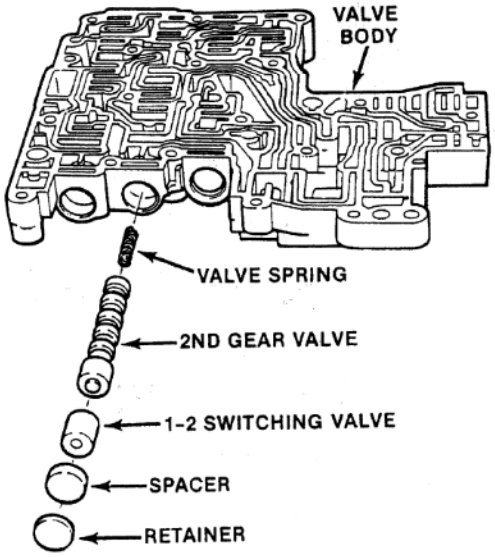
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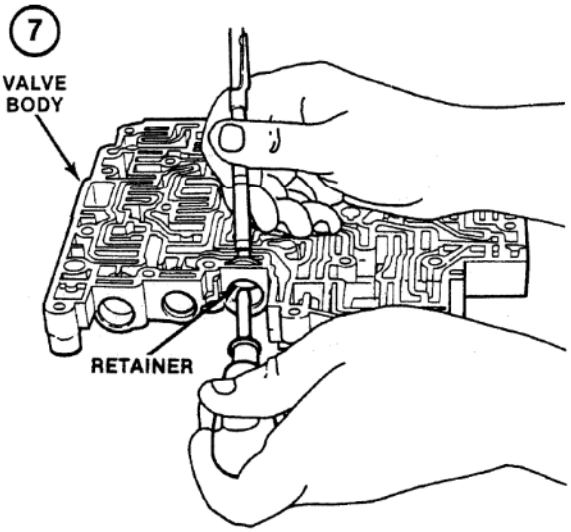


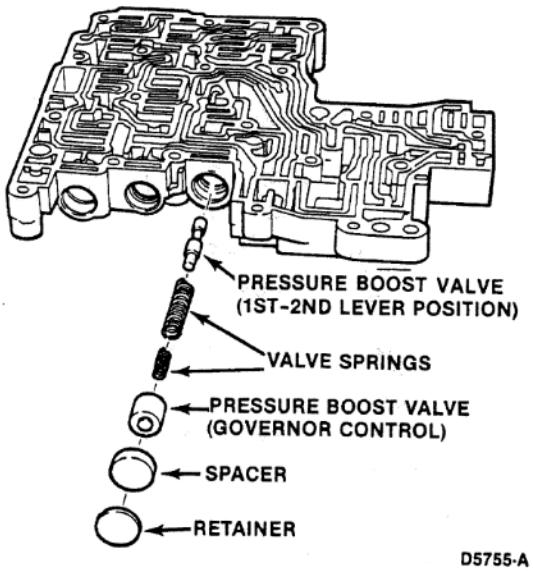
DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

VALVE BODY

Disassembly and Assembly (Continued)

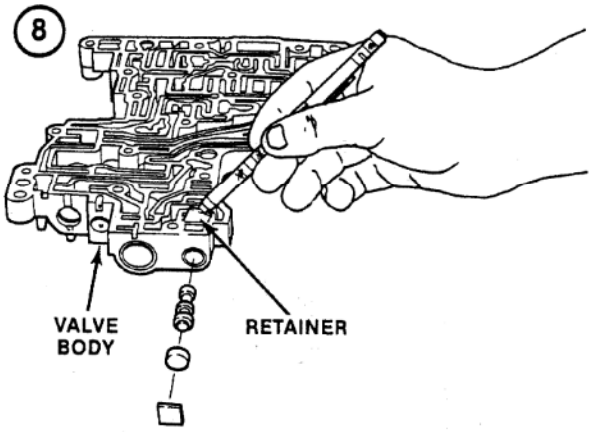
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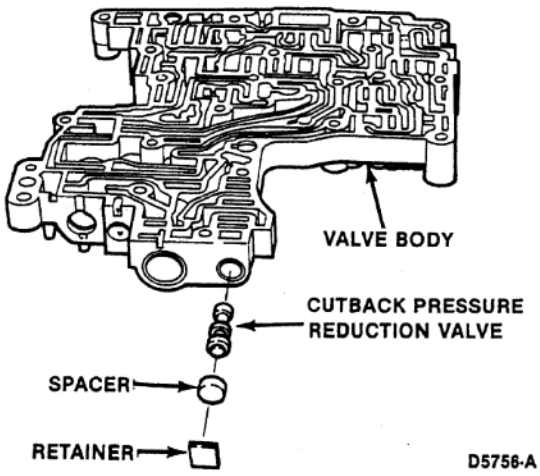




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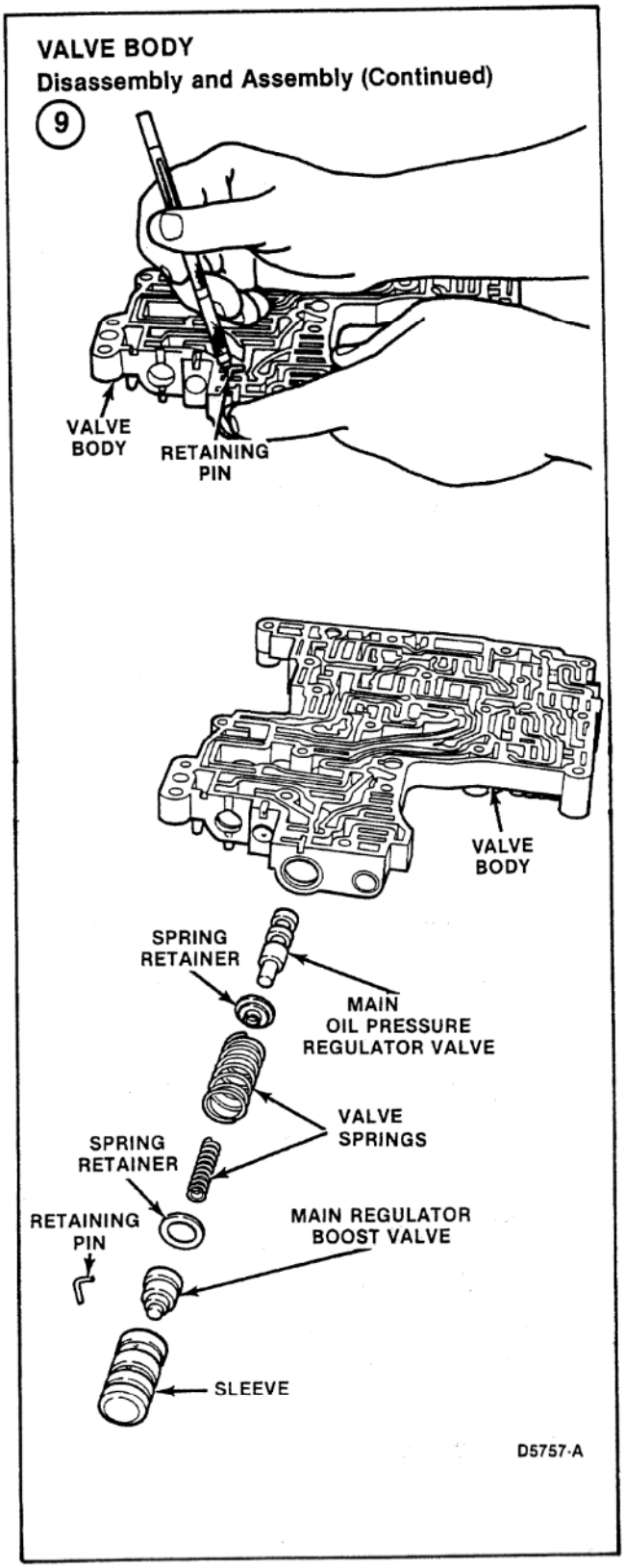


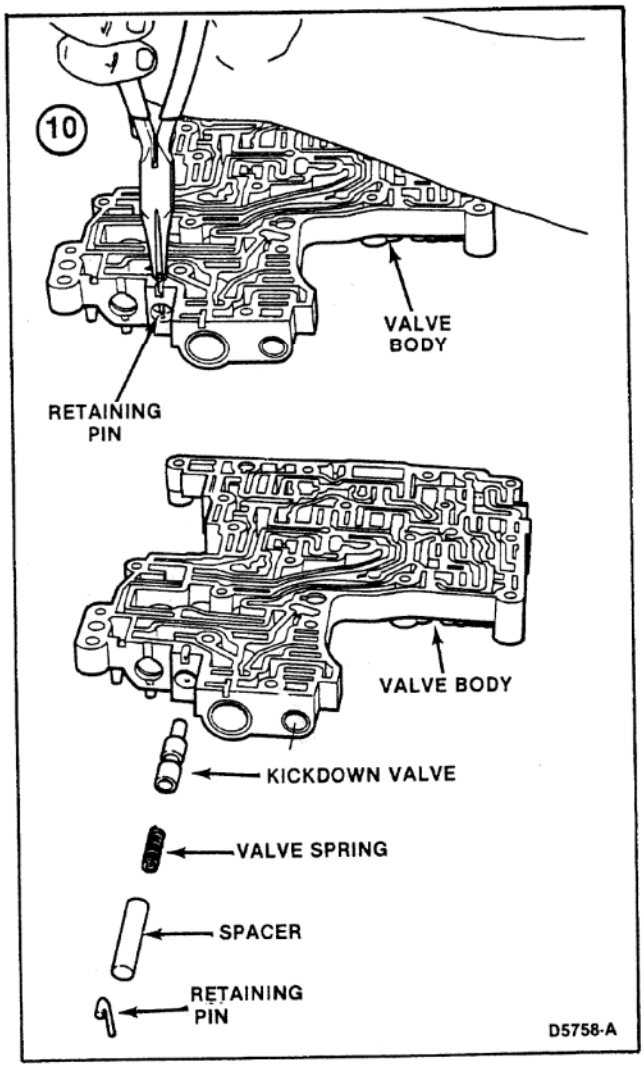


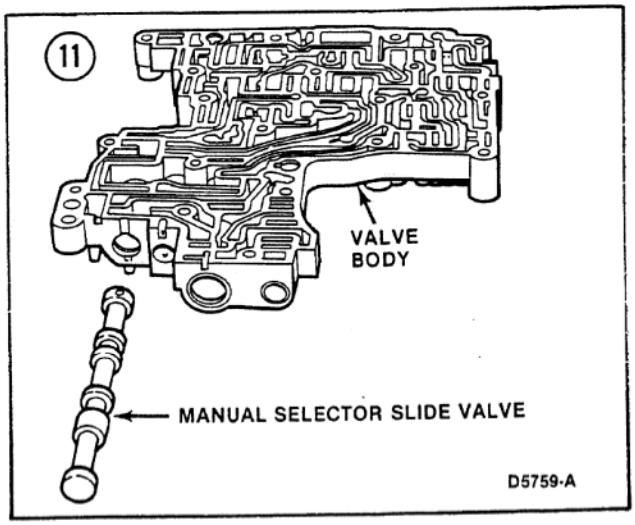
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DISASSEMBLY AND ASSEMBLY/SUBASSEMBLIES

VALVE BODY
Disassembly and Assembly (Continued)

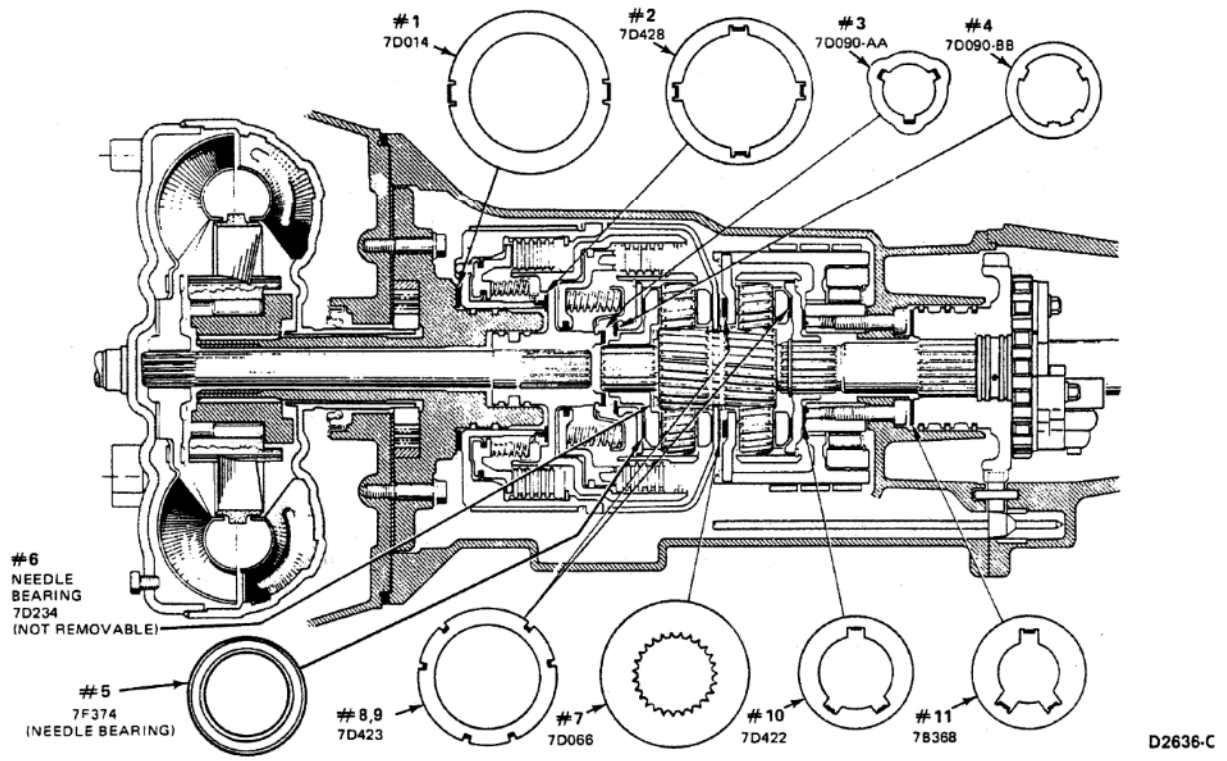


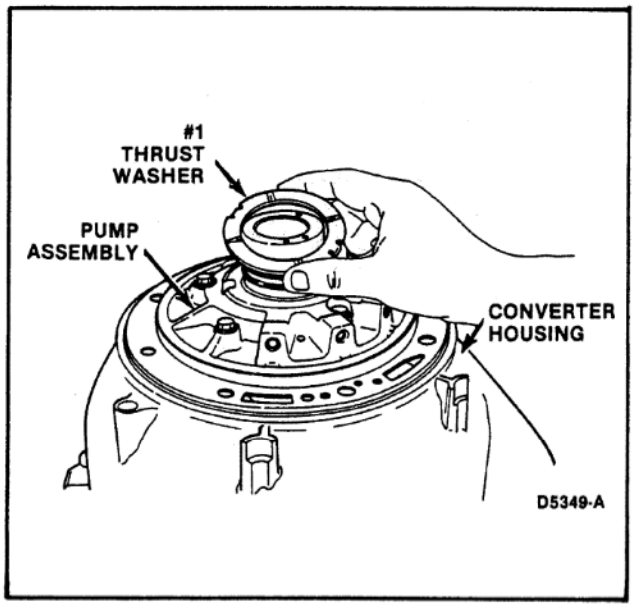


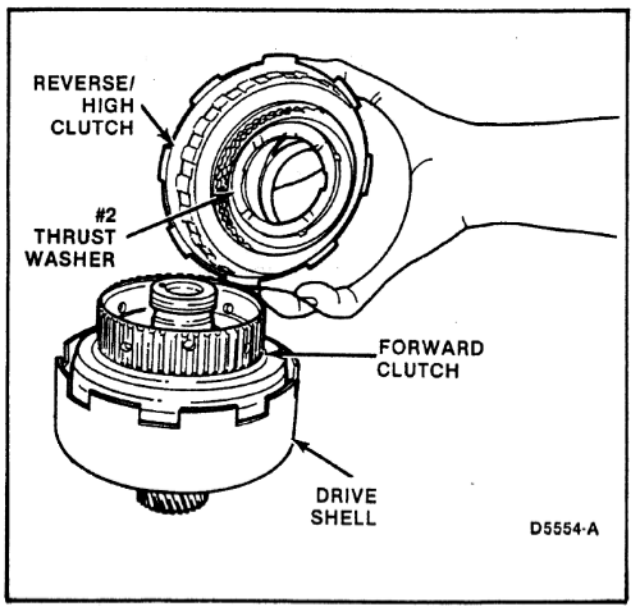


DISASSEMBLY AND ASSEMBLY

THRUST WASHER/BEARING LOCATOR

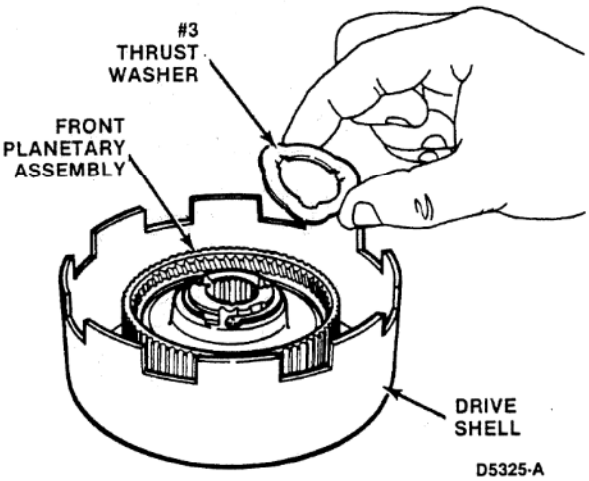


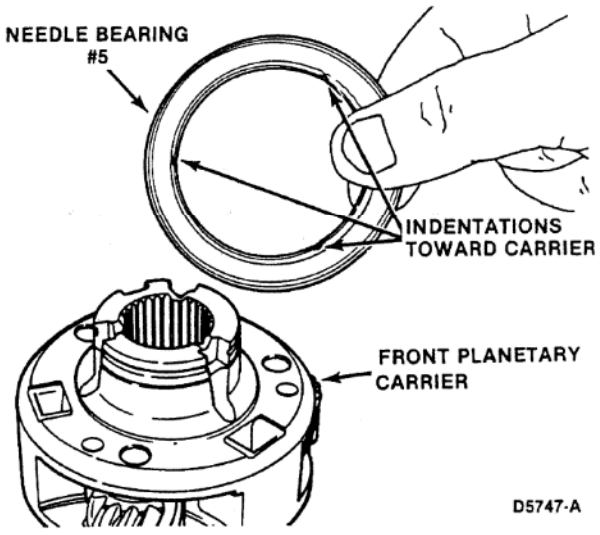


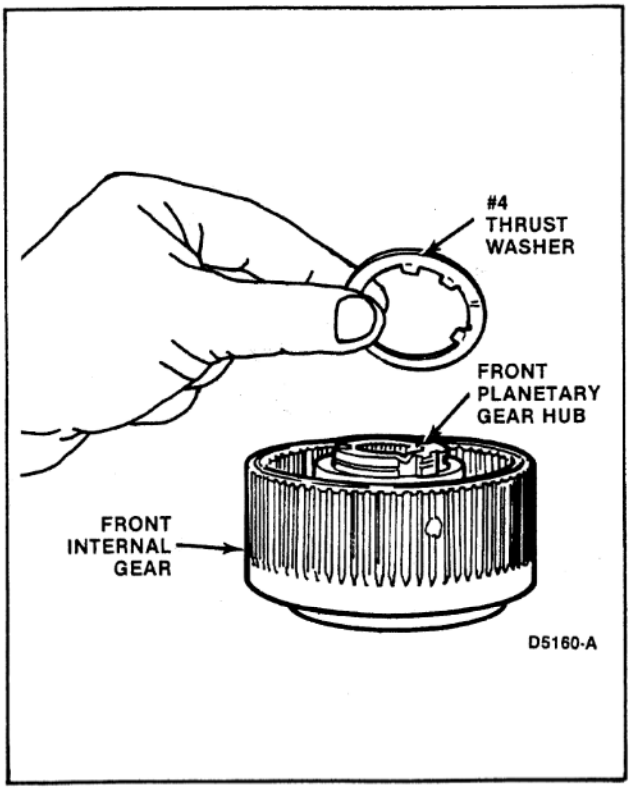


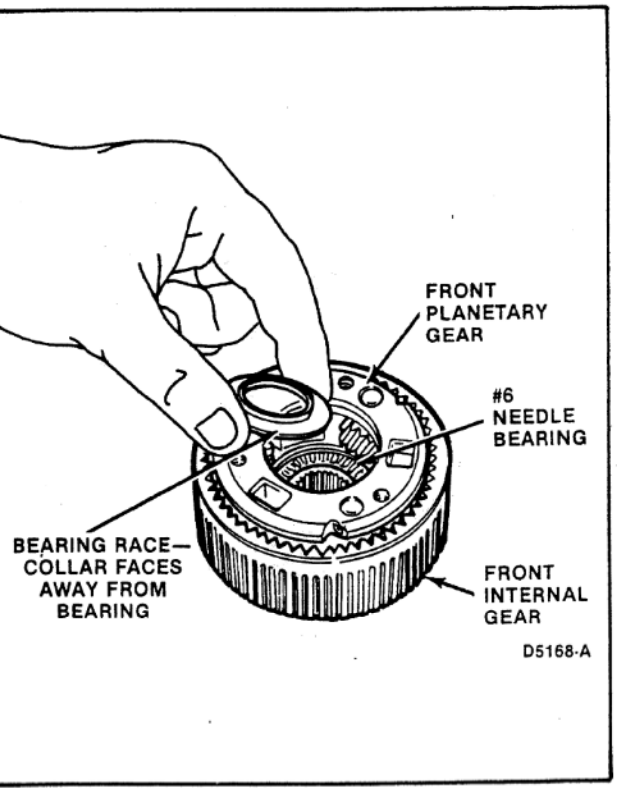
DISASSEMBLY AND ASSEMBLY

THRUST WASHER/BEARING LOCATOR (Continued)



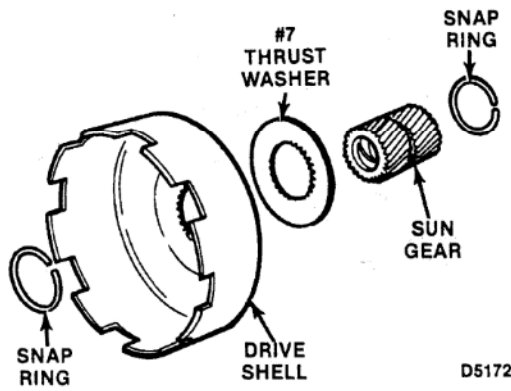


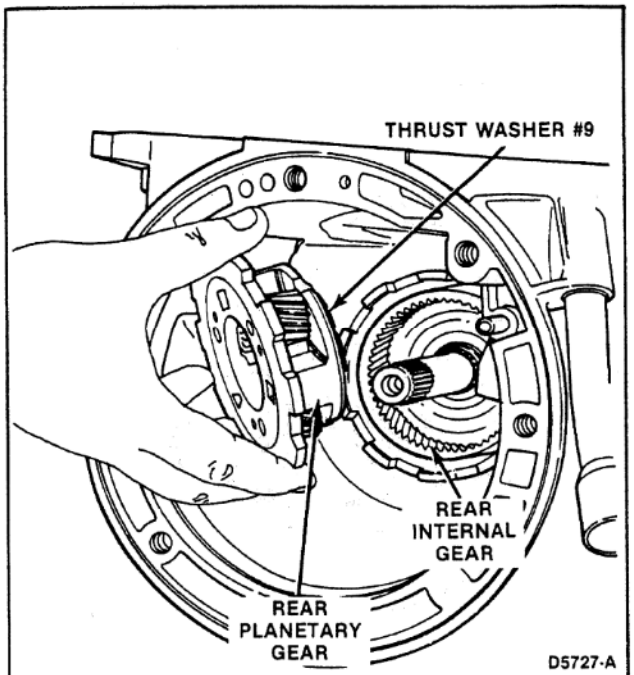


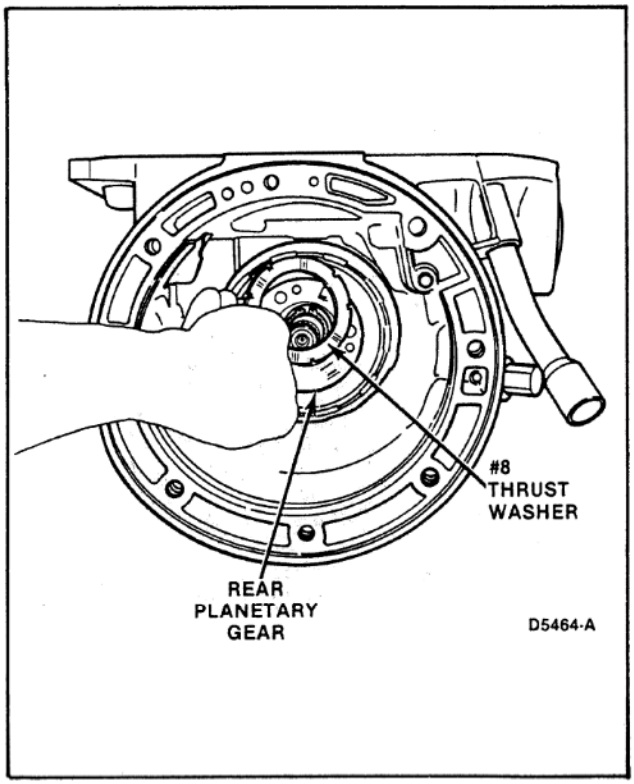


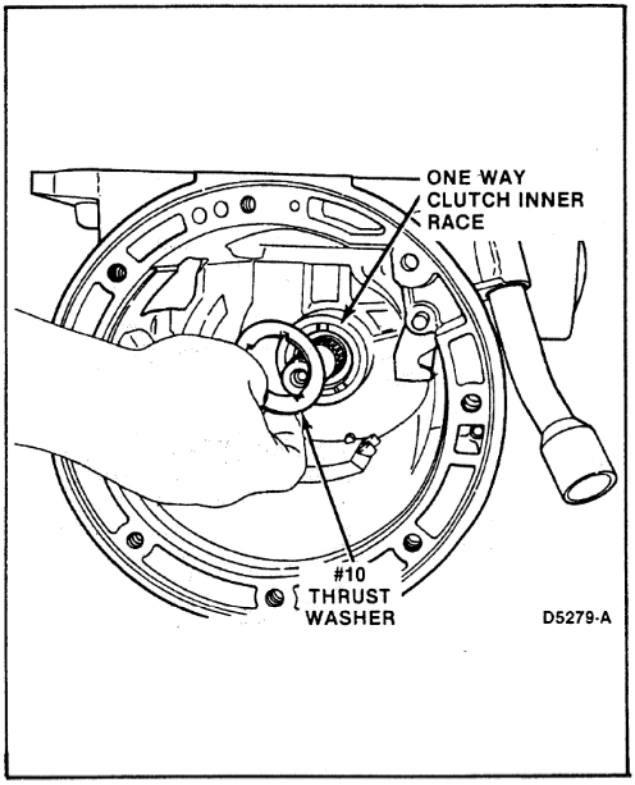
DISASSEMBLY AND ASSEMBLY

THRUST WASHER/BEARING LOCATOR (Continued)



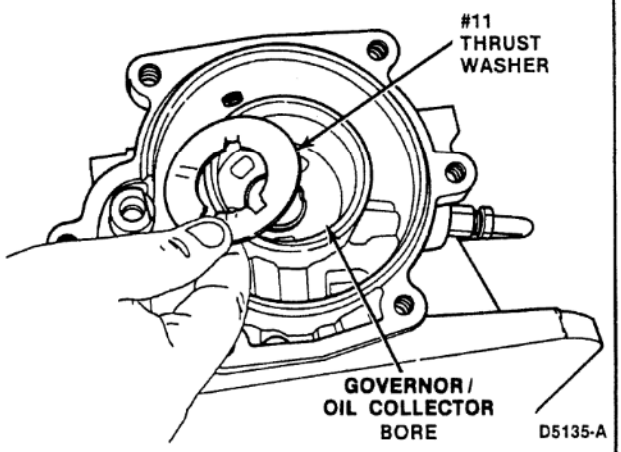






DISASSEMBLY AND ASSEMBLY

THRUST WASHER/BEARING LOCATOR (Continued)



GROUP 17 SPECIFICATIONS

SELECTIVE THRUST WASHERS

		Part Numbers	Thickness	ID Number
End Play .001-.025 (Less Gasket)	No. 1 Thrust Washer Front Pump Support (Selective)	74DT-7D014-EA	0.1091-0.1110	5
		74DT-7D014-DA	0.0929-0.0949	4
		74DT-7D014-CA	0.0768-0.0787	3
		74DT-7D014-BA	0.0610-0.0630	2
		74DT-7D014-AA	0.0488-0.0508	1

SELECTIVE SNAP RINGS

Reverse/High Clutch					Forward Clutch				
	Thickness		Diameter			Thickness		Diameter	
Part Number	mm	Inches	mm	Inches	Part Number	mm	Inches	mm	Inches
E 860126-S	1.37	.0539	130.1	5.122	E 860115-S	1.37	.0539	125.1	4.925
E 860127-S	1.73	.0681	130.1	5.122	E 860116-S	1.73	.0681	125.1	4.925
E 860128-S	2.08	.0819	130.1	5.122	E 860117-S	2.08	.0819	125.1	4.925
E 860129-S	2.44	.0961	130.1	5.122	E 860118-S	2.44	.0961	125.1	4.925

CHECKS AND ADJUSTMENTS

Operation	Specification
Transmission End Play	.001-.025 (Less Gasket)
Turbine and Stator End Play	New or Rebuilt — 0.023 Max.; Used — 0.050 Max.
Intermediate Band Adjustment	Remove and discard locknut. Install new locknut. Tighten adjusting screw to 10 lb-ft torque. Back off 2 turns. Hold screw and tighten locknut.

APPROXIMATE REFILL CAPACITY*

U.S. Measure Qts.	Liters
8	7.6

*Use fluids meeting specification Dexron®II Series D.

CLUTCH AND BAND APPLICATION CHART—Refer to Page 17-01-23

SHIFT SPEED CHART—Refer to Page 17-01-23

PRESSURE TEST SPECIFICATIONS—Refer to Page 17-01-26

TORQUE CONVERTER STALL SPEED—Refer to Page 17-01-30

TORQUE SPECIFICATIONS

Description	N·m	Lb-Ft	Description	N·m	Lb-Ft
Converter Housing to Case	37-52	27-39	Nut — Downshift Lever — Outer	10-14	7-11
Extension Housing to Case	37-52	27-39	Nut — Manual Lever — Inner	41-54	30-40
Oil Pump to Converter Housing	10-13	7-10	Neutral Switch to Case	10-14	7-10
Flywheel to Converter	37-66	27-49	Front Band Adjusting Locknut	48-61	35-45
Main Control to Case	8-11	71-97 (lb-in)	Vacuum Diaphragm Retaining Clip to Case	9-12	80-106 (lb-in)
Plate to Valve Body	10-12	7-9	Oil Cooler Line or By-pass Tube to Connector	10-13	7-10
Servo Cover to Case	10-13	7-10	Connector to Case	14-20	10-15
Oil Pan to Case	16-23	12-17	Flywheel to Crankshaft	66-71	48-53
Governor to Collector Body	9-14	84-120 (lb-in)	Filler Tube to Engine Clip	38-51	28-38
Converter Housing to Engine	38-51	28-38			

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NOISE, VIBRATION AND HARSHNESS

GROUP 18

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NOISE, VIBRATION AND HARSHNESS

GROUP 18

SECTION 18-01 Noise, Vibration and Harshness

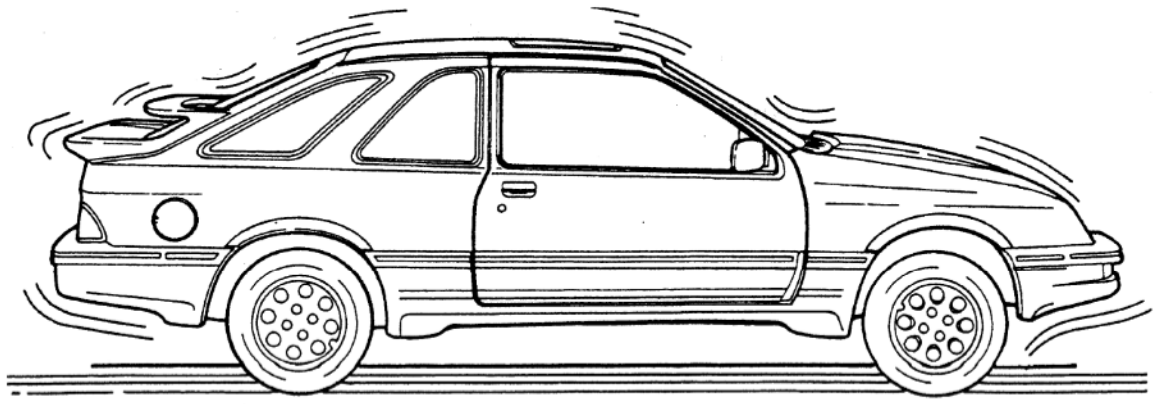
SUBJECT	PAGE
DIAGNOSTIC PROCEDURES	
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NVH TROUBLESHOOTING CHART	18-01-2

GENERAL INFORMATION

The information in this section will provide a working knowledge of the process required to diagnose a noise, vibration, or harshness situation. Before attempting to diagnose an NVH condition, read the Diagnostic Theory and Glossary of Terms in this Section.

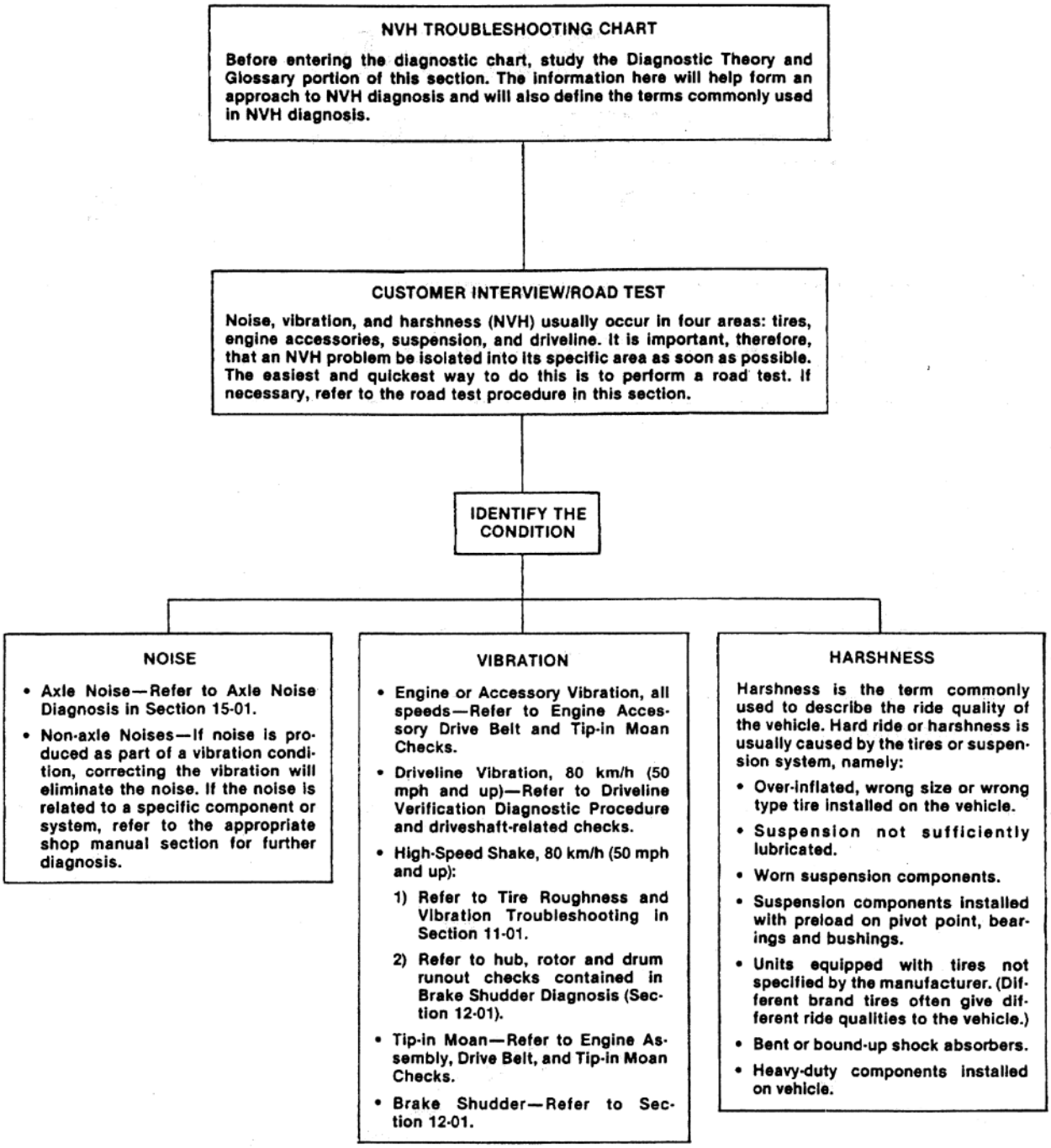
After becoming familiar with the methods and terms used in NVH diagnosis, proceed to the NVH Troubleshooting Chart to begin the diagnosis. The most important part of this chart is the road test. The wide range of NVH is defined and narrowed to a specific area of the vehicle.

With the type of condition known, the Diagnostic Procedures should be used to define the diagnosis of a specific component. After making any repair, always road-test the vehicle to confirm that the condition has been corrected to the owner's satisfaction.



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NVH TROUBLESHOOTING CHART



CF4985

DIAGNOSTIC PROCEDURES

Diagnostic Theory

Diagnosis is more than just following a series of interrelated steps in order to find the solution to a specific condition. It is a way of looking at systems that are not functioning the way they should and finding out why. Also it is knowing how the system **should** work, and whether it is working correctly. If you check closely, you will find that all good diagnosticians use the same basic procedure.

There are basic rules for diagnosis. If you follow these rules, you will usually find the cause of the condition on the first time through the system.

Know the System

This means know how the parts go together, how the system operates and its limits, and what happens when something goes wrong. Sometimes this means getting your hands on a system that is working properly and checking it against the one you are working on.

Know the History of the System

How old or new is the system? What kind of treatment has it had? Has it been serviced in the past in such a manner that might relate to the present condition? What is the service history? A clue in any one of these areas might save a lot of diagnosis time.

Know the History of the Condition

Did it start all of a sudden, or did it appear gradually? Was it related to some other occurrence like an accident or previous part replacement? Know how the condition made itself known; it may be an important clue to the cause.

Know the Probability of Certain Conditions Developing

It is true that most conditions are caused by simple things rather than by complex ones, and they occur in a fairly predictable pattern. Be sure you know the difference between **impossible and improbable.** Many a good technician has spent hours diagnosing a system because he thought certain failures were "impossible" only to, eventually, find out the failures were just "improbable" and actually had happened. A thing to remember is that new parts are just that: new. It does not mean they are always good, functioning parts.

Don't Cure the Symptom and Leave the Cause

Lowering the air pressure in a front tire may correct the condition of a vehicle leaning to one side, but it does not correct the original problem.

Be Positive the Cause Is Found

Do not be fooled into thinking you have found it when you have not. Double-check your findings. If you find a worn component or something out of adjustment, ask yourself: "What else could be wrong?" If one of the engine mounts was loose, could the other one be loose, too? What about the transmission mounts? Build up a picture in your mind of the relationship of the affected parts.

Diagnosis Charts

No matter what form charts may take, they are simply a way of expressing the relationship between basic logic and a physical system of components. It is a way of letting you "corner" the cause of a condition in the shortest possible amount of time. Diagnosis charts combine many areas of diagnosis into one visual display.

- Probability of certain things occuring in a system.
- Speed of checking certain components, or functions, before others.
- Simplicity of performing certain tests before others.
- Elimination of checking huge portions of a system by performing simple tests.
- Certainty of narrowing down the search to a small portion before performing in-depth testing.

After working with diagnosis charts for a while, you will find that the fastest way to find a condition is to work with the tools that are available, and this means working with proven diagnosis charts and the proper special tools for the system you are working on.

Road Test

The NVH diagnosis road test starts with the customer interview. The service writer must get as much information as possible about the problem and, if possible, take a test drive with the customer, to minimize confusion arising from descriptive language differences. The history of the problem must be investigated: When was it first noticed? Did it appear suddenly or gradually? Did any abnormal occurrence coincide with or precede its appearance (such as pothole or curb impacts, minor collisions, etc.)? Were any service procedures performed or parts replaced? It is also necessary to know any special conditions affecting the appearance and degree of the problem, such as road speed, type of road, drive mode, engine temperature, ambient temperature, etc.

A gradual appearance of the problem indicates a deterioration of a component, such as tires, U-joints, an accessory drive belt, or a wheel bearing.

A sudden appearance of the problem could indicate a lost wheel balance weight, frozen U-joint or lost driveshaft balance weight.

NOTE: Information gained from the problem description should never be used in place of facts gained from diagnosis, nor should it be used as an attempted short cut fix. In the long run, time will be saved by adhering to the diagnostic procedures shown.

After reviewing the customer interview, the road test will provide much of the information that will allow you to identify the condition you are dealing with, steering you to the correct starting point for diagnosis.

NOTE: Always use a tachometer in road testing and record engine rpm as well as road speed for conditions noted.

DIAGNOSTIC PROCEDURES (Continued)

1. Make notes throughout diagnosis routine. It will help cover all the bases when starting to add up the clues. Use a photocopy of the NVH Road Test Form shown on the next page. Make sure to write down even the smallest bit of information; it may turn out to be most important.
2. Perform the road test checks to bring out the problem condition. This will identify the proper section of the diagnosis procedure. Run through the check procedure more than once to be sure you are getting a useable result.

NOTE: The road test checks may not always tell where the problem is, but they will often eliminate other unnecessary checking for you.

3. Do not touch or repair anything until a road test and a thorough visual inspection of the vehicle have been performed. Leave the tire pressures and vehicle load just where they were when the customer brought the vehicle in. Adjusting tire pressures, vehicle load, or making some other seemingly innocent adjustment may reduce the item's intensity to a point where it cannot be identified clearly; it may also inject something new into the system that the customer was not even aware of, preventing proper diagnosis. Make a visual inspection as part of the preliminary diagnosis routine, writing down anything that does not look right. Note tire pressures, but do not adjust them yet. Note leaking fluids, loose nuts and/or bolts, or bright spots where components may be rubbing against each other. Check the trunk or cargo area for unusual loads or damage.

NOTE: It is important that rear axle noise on vehicles equipped with the manual, 5-speed overdrive transmission be evaluated in direct drive (4th) rather than overdrive (5th).

DIAGNOSTIC PROCEDURES (Continued)

NVH ROAD TEST FORM

CUSTOMER INTERVIEW

Did condition exist when vehicle was new: ☐ YES ☐ NO Mileage: _____

Did condition occur: ☐ GRADUALLY ☐ SUDDENLY

Owner's Description of Condition: _____

_____

IDENTIFY THE CONDITION (Use the following descriptions.)

NOISE:

☐ Non-axle noises—noise, defined as any unpleasant sound, may be described in a variety of ways such as tapping, whistling, buzzing, humming, clunking, or booming. You can associate these various descriptions of noise with a probable cause. Based on experience, these descriptions will assist in isolating the problem and correcting it. Generally recognizable problem areas are engine, driveline, wind and road surface noises. Other less obvious areas that should be considered as noise problem sources are any of the problems that cause the vibrations described below.

☐ Axle noises—a gear-driven unit, especially an automotive drive axle, will produce a certain amount of noise. Some noise is acceptable and may be audible at certain speeds or under various driving conditions, for example, as on a newly paved blacktop road. The slight noise is in no way detrimental to the operation of the rear axle and must be considered normal. Conditions affecting the drive axle can create various whines or knocking noises that vary in intensity and pitch with road speed, and may or may not respond to drive mode changes.

Vibration:

Vibration, technically, is a high-frequency trembling, shaking or grounding condition, felt or heard, that is constant or variable in level and occurs during a portion of the total operating speed range.

☐ Engine or accessory vibration (all speeds)—this vibration occurs at any vehicle speed but always at the same engine rpm. It will disappear in Neutral coast. The vibration can be duplicated by operating the engine at the problem rpm while the vehicle is sitting still. It can be caused by any component from the fan back to the clutch or torque converter and by anything that turns at engine speed when the vehicle is stopped.

☐ Driveline vibration, 80 km/h (50 mph and up)—this is not a visible vibration, but can be felt in the floor pan as a rumble, buzz, hum, drone or boom. It is independent of engine speed, and will occur at the same speed in any gear. It will exist in all drive modes, but may vary somewhat in acceleration, deceleration, float, or coast modes. In some cases the driveline vibration is eliminated in the float mode. At high speed, if a vibration is felt in the floor pan or seats, with no visible shake of vehicle components with an accompanying sound, or sensation of sound (rumble, buzz, hum, drone, or booming noise), the probable cause is driveline runout/balance.

CF4178-A1

DIAGNOSTIC PROCEDURES (Continued)

NVH ROAD TEST FORM (Continued)

- ☐ High speed shake, 80 km/h (50 mph and up)—this condition produces a visible shake and pumping feel in the steering column, seats or floor pan. It is a low-frequency vibration (around 9-15 cycles per second) and can sometimes be seen as front end sheet metal shake. It may or may not be increased by applying brakes lightly.
- ☐ Tip-in moan, 24 to 80 km/h (15 to 50 mph)—when accelerating between 24 to 80 km/h (15 to 50 mph), this vibration produces a "moan" or high-frequency feel in the floor pan. It is usually worse at a particular engine speed and at a particular throttle setting during acceleration at that speed. It may also produce a moaning sound, depending on what component is causing it.
- ☐ Brake shudder—steering wheel vibration and brake pedal pulsation during light braking. Most apparent when braking from 112 to 120 km/h (70 to 75 mph).

Harshness

- ☐ Harshness is the term commonly used to describe the ride quality of the vehicle. Hard ride or harshness is usually caused by the tires or suspension system.

CF4178-A2

Driveline Vibration Verification

Driveline runout and/or balance can cause a vibration of a higher frequency than a vibration which originates in the tire and wheel assembly. To determine whether a driveline vibration is present, the rear of the vehicle should be supported on stands or twin-post hoist under the rear axle. Remove the rear wheels and install M21 nuts to retain the brake drums.

NOTE: Before you remove the wheels, make sure that they are properly marked for reassembly in the same position.

Run the vehicle driveline in the vibration mph range and note any vibration, sound, or sensation of sound (rumble, buzz, hum, drone or booming noise). If a vibration is present, proceed with driveshaft and companion flange runout check. If not, proceed to Tire Roughness and Vibration Troubleshooting in Section 11- 01.

Engine Run-Up Check

This procedure is useful in separating driveline and tire vibration from engine and accessory vibration. A tachometer is required to correlate engine speed with vehicle speed. Run the engine up to the problem rpm (encountered on the road) with the vehicle stationary and the transmission in Park or Neutral and then in Drive range (stall test), with the wheels blocked and brakes applied.

CAUTION: While making this test in the Drive range on automatic transmission equipped vehicles, do not hold the throttle open for more than five seconds at a time. Then move the selector lever to Neutral and run the engine at 1000 rpm for 15 seconds to cool the converter.

On standard transmission equipped units, run the engine up to the vibration rpm (transmission in neutral) with the clutch engaged and disengaged. With automatic transmissions, if the vibration persists in either Park or Neutral, the disturbance may be caused by the engine, or accessory such as the A/C compressor when engaged, the flywheel or flex plate, clutch or torque converter, or an input component within the transmission. However, if the vibration exists in Drive range, then the disturbance may be caused by bound-up transmission and/or exhaust system components.

NOTE: Because the vehicle is stationary during the engine run-up checks, other noises and/or vibrations will become evident which were not evident under normal driving conditions. For instance, all engines have a natural vibration frequency which can be felt in neutral but not under normal driving conditions. For this reason, the use of a tachometer is mandatory to verify the presence of the actual condition.

DIAGNOSTIC PROCEDURES (Continued)

Engine Accessory Drive Belt Check

In many instances, a vibration verified by the engine run-up check is simply due to a loose accessory bracket or drive belt. For this reason, all accessory attaching bolts should be checked for proper torque and all drive belts checked for proper tension with a belt tension gauge.

Visually inspect all drive pulleys, belts, and pulley alignments. Any of the above conditions in the accessory drive systems could initiate a vibration. Bent or nicked pulleys may require replacement. Badly worn, frayed, or nicked belts must be replaced. Pulleys must be properly aligned. Inspect the fan, fan spacer or clutch, and water pump pulley for damage and burrs or foreign materials that may cause poor seating between any of the components.

Watch the drive belts with the engine running in Neutral at the vibration speed. If one of the belts experiences severe "belt whip" at this speed, this accessory or drive system may be contributing to the condition.

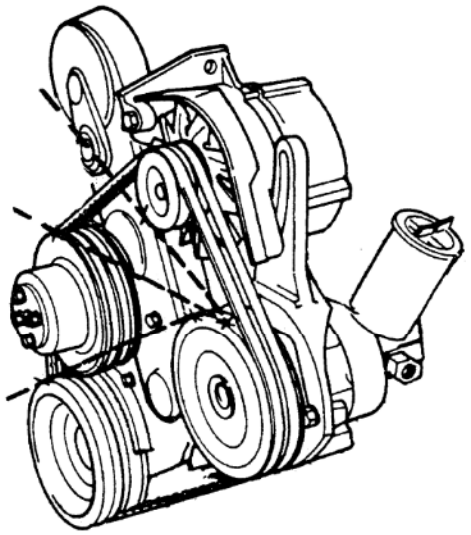
Watch the drive pulleys with the engine running at idle. Replace any pulley which exhibits radial or axial runout in excess of 3.175mm (1/8 inch).

Watch the belts ride in the pulleys at idle speed. If the belt appears to ride up and down the pulley, the sheave width is not constant and the pulley must be replaced.

A stethoscope or other probing device may save time in diagnosing an accessory vibration. Probing at the vibration speed, with the engine running in Neutral, will often immediately pinpoint the condition. If this proves unsatisfactory, remove the drive belts one at a time, until the vibration is reduced or eliminated. The last belt removed thus pinpoints the accessory or drive system contributing to or causing the condition. In some cases belt removal will not eliminate an accessory vibration and it becomes necessary to remove the accessory from its mountings.

Once the vibration area has been located, the drive belt should be replaced first as construction variations in the belt may not be evident upon visual inspection and can set up a vibration.

When the belt and related pulleys and accessory attachments are determined to be acceptable, replacement of the accessory may be necessary.



PULLEYS MUST BE ALIGNED IN SAME PLANE G4655-A

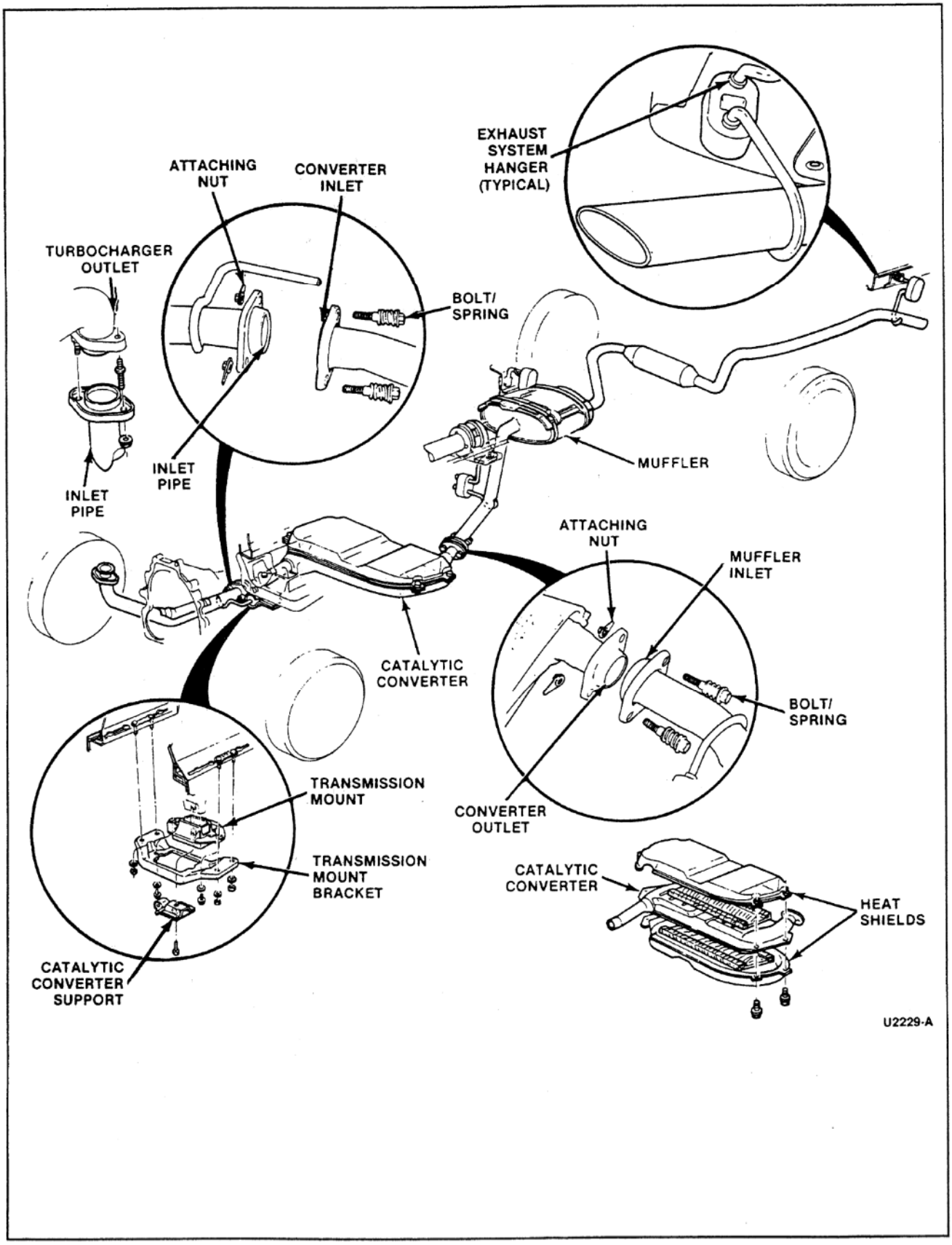
Neutralize Transmission Mount and Exhaust System

An abnormal vibration can be caused by a component, such as a transmission mount, which is acting in a rigid manner because of a distorted or twisted mounting position. As a result, the mount does not absorb vibrations as it should. Grounded or abnormally strained exhaust system and hangers will also lead to this condition.

To neutralize the transmission mount, loosen the attaching bolt, start the engine, shift to Drive while idling, then shift back to Neutral, shut off the engine and retorque the bolt.

The exhaust system must be neutralized while it is hot because the thermal expansion of the pipe will otherwise place a strain on the hangers. While the exhaust system is at its normal operating temperature, loosen all attaching bolts and reposition as required so that they hang free and straight. Next, loosen the flanges at the manifolds, start the engine, shift to Drive while idling and shift back to Neutral, then shut off the engine and retorque all flange and attaching bolts. Be certain that no grounding condition exists and that adequate clearance exists along the entire length of the exhaust system.

DIAGNOSTIC PROCEDURES (Continued)

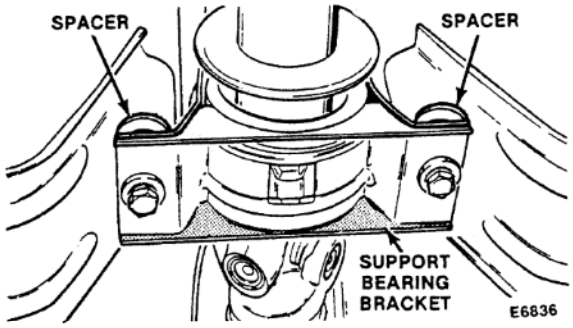


DIAGNOSTIC PROCEDURES (Continued)

Neutral Coast Test

A neutral coast test is a good method to determine if the engine, driveline, wheels or tires are causing the vibration. To do this, accelerate to high speed and place the transmission selector in Neutral and allow engine to return to idle speed. If the vibration exists in this condition, the investigation can be confined to the transmission output shaft, driveshaft, axle, wheels or tires, eliminating the engine and accessories from suspicion. If the vibration does not exist during neutral coast, perform an engine run-up check.

NOTE: Before making any driveline checks, lower the driveshaft center support bearing bracket and make sure the 4mm spacers are in place between the body and the bearing bracket.



Driveshaft Alignment Procedure

Aligning and centering the (two-piece) driveshaft may resolve a driveline vibration as described below:

1. A severe but temporary driveline vibration after the vehicle has been parked in extreme cold temperatures for an extended period. This symptom will go away after 3 to 4 miles of driving but will recur when the vehicle is again parked in extreme cold for an extended peroid.
2. Driveline vibration that is much less severe than condition 1, but can be felt in the floor of the car after the vehicle is warm (or in ambient temperatures above freezing). This driveline vibration is most often felt when driving away from a full stop but on some vehicles can be felt at highway speeds.

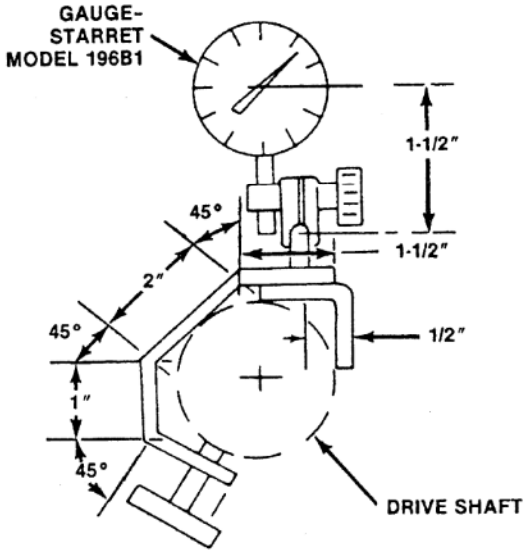
Driveline vibration in both driving conditions is caused by improper driveline alignment.

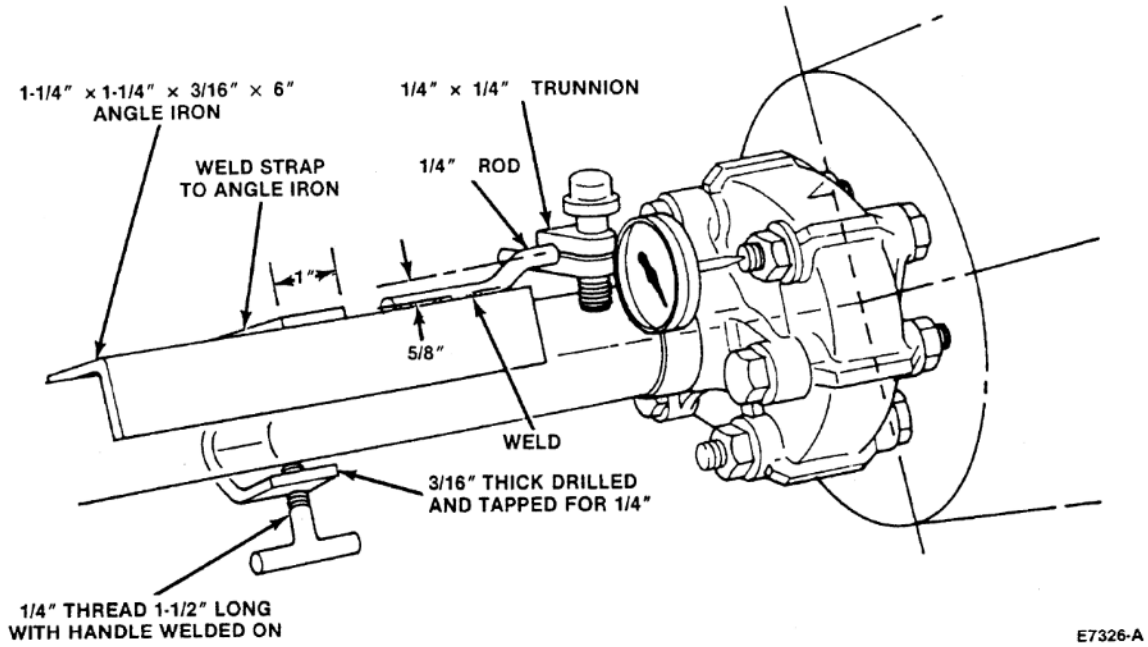
NOTE: Driveline alignment on the XR4Ti is measured at the rubber joint/damper (guibo joint) at the front of the driveshaft. Any misalignment is measured as runout at the guibo joint.

To check and set driveshaft guibo joint runout, a dial indicator that indicates off the back of the gauge (such as Starrett Model No. 196B1) Special Tool Number TOOL-4201-C, must be used with a 1/4 inch x 1/4 inch trunnion and a fabricated fixture which mounts the indicator to the driveshaft. The fixture must be fabricated as shown here.

DIAGNOSTIC PROCEDURES (Continued)

DIAL INDICATOR AND FIXTURE
SPECIAL SERVICE TOOL NUMBER
TOOL-4201-C





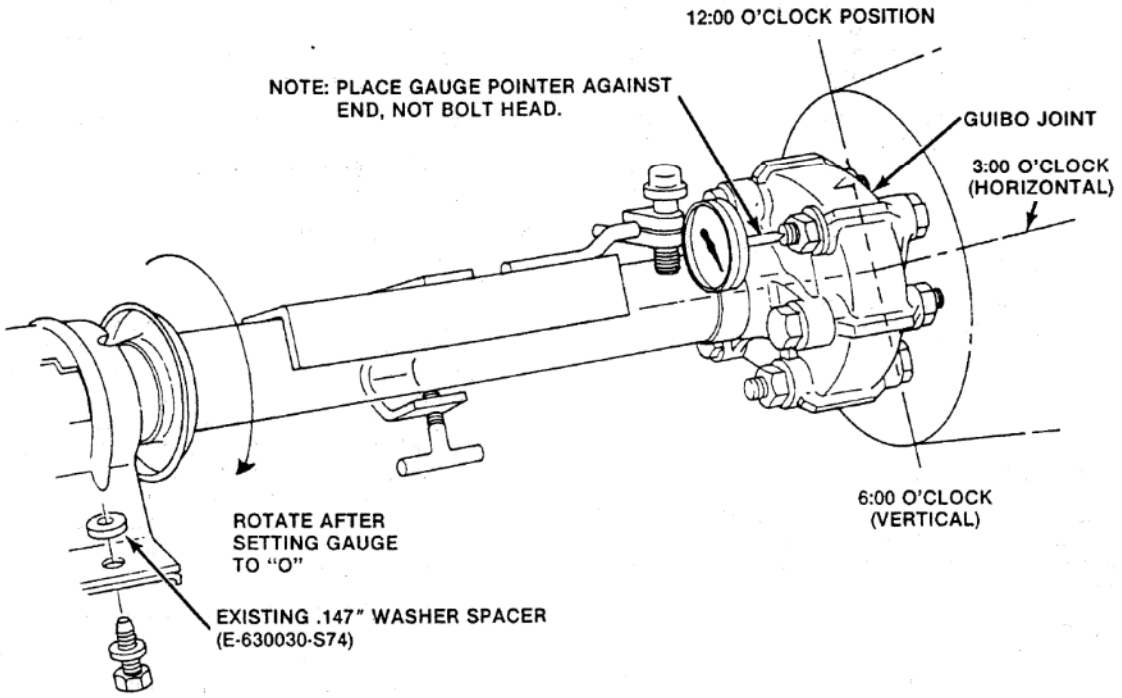
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DIAGNOSTIC PROCEDURES (Continued)

To perform alignment of the driveline guibo joint, the following procedure must be followed.

A. Raise the vehicle in such a manner that the rear wheels are free to rotate. (Transmission in neutral and the emergency brake released).

B. Verify the vehicle is properly assembled with a spacer (quantity of 2, one on each side) between the body and the driveshaft center bearing.



C. After checking that the vehicle is properly shimmed, check/set the runout of the guibo joint as follows:

1. Using the dial indicator tool (fabracated as detailed in illustration) clamp the tool to the driveshaft as shown in illustration and determined the driveshaft angularity by measuring the rubber guibo joint rotational runout while rotating the rear wheels. Vertical alignment can be determined by the difference in dial gauge readings between the 6:00 and 12:00 o'clock positions as described on the sketch. Horizontal alignment is the difference in the dial gauge readings between 3:00 and 9:00 o'clock positions.
2. If either the vertical or horzontal misalignment exceeds 0.005 inch on the dial indicator, an adjustment must be made to make the alignment as close to .000 inch as possible.

a. For vertical alignment adjustment: With the dial indicator placed on a bolt end as shown at the 6:00 o'clock position (after zeroing the gauge at 12:00 o'clock) push up and down on driveshaft near the center bearing while watching the dial reading to determine if the center bearing is to be adjusted upwards or downwards.

1. If center bearing is to be adjusted upwards, remove the washer spacers from between the center bearing and the body and refasten the bearing to the body.
2. If center bearing is to be adjusted downwards, add to the existing washer spacer on each side an additional 3/16 inch thick flat washer.

DIAGNOSTIC PROCEDURES (Continued)

b. For horizontal alignment adjustment: With dial indicator at the 9:00 o'clock position (after zeroing out at 3:00 o'clock) push shaft (near center bearing) from side to side while observing the dial reading to determine direction the bearing is to be moved to align the shaft. Loosen the center bearing attachment bolts and move the bearing in this direction approximately 1/8 inch. Snug bearing bolts and check alignment again. Re-align if required.

3. With vertical and/or horizontal adjustments made and center bearing bolts snug, re-measure the alignment to verify that both vertical and horizontal readings are less than 0.005 inches on the dial gauge. Remove gauge.
4. Tighten center bearing bolts to 18-23 N·m (13-17 ft-lbs).
5. Lower vehicle.

Driveshaft Indexing Procedure

An additional check which can be performed if driveshaft alignment does not correct the vibration and driveshaft imbalance is suspected is reindexing the driveshaft assembly.

A vibration-free driveline can result from the driveshaft indexing procedure when minor driveshaft imbalance is canceled by minor pinion flange runout. If driveshaft indexing is not successful, replace driveshaft.

To reindex the driveshaft assembly, mark its original position, disconnect from the companion flange, rotate 180 degrees and install the attaching bolts.

After reindexing, evaluate on the hoist. If necessary, refer to the Driveline Vibration Verification Procedure in this Section. If the vibration is still present, install the driveshaft in its original position and proceed to the Driveshaft and Companion Flange runout check.

Driveshaft and Companion Flange Runout Check

1. Check the runouts at the front, center, and rear of the driveshaft. The runout at the rear of the shaft should be made on the tube as close to the universal joint as possible.

NOTE: Turn the rear wheel/drum to rotate the driveshaft when checking driveshaft runout.

2. Mark the points of the greatest runouts on the driveshaft. If the runout is .889mm (.035 in.) or more at the front or center of the driveshaft, replace the driveshaft.
3. If the runout at the rear is less than .889mm (.035 in.) and the front and center runouts are also less than .889mm (.035 in.), proceed to driveshaft balance.
4. If the runout at the rear is more than .889mm (.035 in.) and the front and center runouts are less than .889mm (.035 in.), mark the point of greatest runout on the shaft.

NOTE: The runout at the rear of the driveshaft can be caused by either the driveshaft or the companion flange.

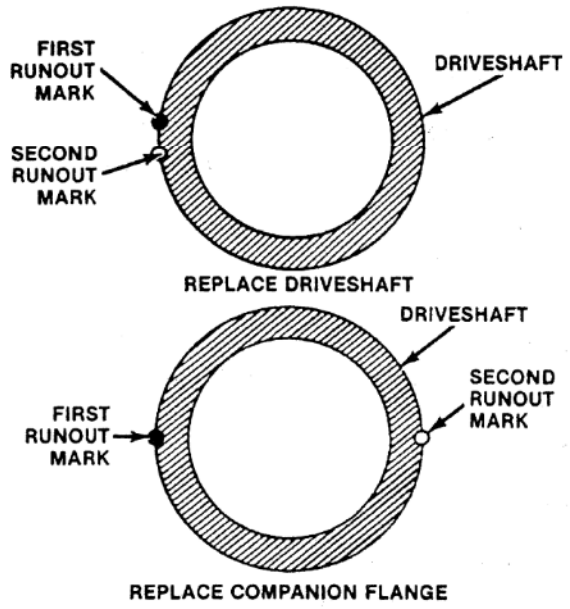
5. To determine the cause of the runout at the rear of the driveshaft, remove and rotate the driveshaft 180 degrees to the companion flange and check and mark the greatest runout at the rear of the driveshaft. If the runout is less than .889mm (.035 in.), evaluate on the hoist. If necessary, refer to the Driveline Vibration Verification Diagnostic Procedure in this Section. Road-test if the vibration is not present. If runout is more than .889mm (.035 in.), proceed to Step 6.
6. Compare the first and second marks at the rear of the driveshaft to determine the cause of the runout. If the marks are within approximately one inch, replace the driveshaft. If the marks are approximately on opposite sides of the shaft, or if the circular flange runout exceeds .076mm (.003 in.) reindex the companion flange 180 degrees. Refer to Section 15-03 for the companion flange removal and installation procedure.

NOTE: The radial and lateral runout on a circular-type companion flange should not exceed .076mm (.003 in.).

7. If the vibration condition continues to exist or if the flange runout is still excessive, replace the companion flange.
8. After replacing the companion flange, recheck runouts. If excessive runout is still evident after replacement of the companion flange, it will be necessary to replace the ring gear and pinion and repeat the above checks until runout is within specification.

DIAGNOSTIC PROCEDURES (Continued)

9. Evaluate on hoist. If necessary, refer to the Driveline Vibration Verification Procedure in this Section. If the vibration is still present, substitute the driveshaft from a known vibration is eliminated, replace the driveshaft. If the vibration remains unchanged, return to the Troubleshooting Chart and Road Test Procedure.



GLOSSARY OF TERMS

Acceleration

1. **Light**—Increase in speed at less than 1/2 throttle.
2. **Heavy**—1/2 to full throttle increase in speed.
3. **WOT**—Wide open throttle.

Ambient Temperature

Surrounding or prevailing temperature. Normally, the temperature in the service area or outdoors, depending on where testing is taking place.

Articulation

Vertical movement of the front driving or rear axle relative to the frame of the vehicle to which they are attached.

Boom

A cycling, rhythmic noise often accompanied by sensation of pressure on the ear drums.

Bound Up

Refers to a stressed, rubber-mounted component that transmits any NVH which would normally be absorbed by the mount. (See Neutralize.)

Brakes Applied

When vehicle is stationary, service brakes applied with enough force to hold vehicle against acceleration with transmission in gear or drive.

Camber

Angle formed between front wheel spindle axis and horizontal as viewed from in front of the vehicle.

Caster

Angle formed between the kingpin axis and a vertical axis as viewed from the side of the vehicle. Caster is considered positive when the top of the kingpin axis is behind the vertical axis.

Center Bearing

Rubber-encased, self-centering bearing used to support driveshaft between coupling shaft and driveshaft.

Coast/Neutral Coast

Engine/transmission taken out of gear with driveshaft/driveline by placing transmission selector in Neutral or by depressing clutch (manual transmission).

CPS

Cycles Per Second (Hertz).

Typical vibration frequencies, measured in cycles per second, (HZ) are:

1. Engine accessories (up to 160 cps). (Usually caused by engine firing pulses.)
2. Engine (40 cps); firing (80 cps).
3. Wheels and tires (13 cps).
4. Driveshaft (40 cps); U-joints (40 cps). The vehicle normally responds to a certain driveline frequency. If the U-joints are the source, the problem will occur at one half the speed of a typical high-speed driveline problem.
5. Wheel bearings (6 cps).

Cruise

Steady highway speed, neither accelerating nor decelerating; even pressure on accelerator pedal on level ground.

Controlled Rear Suspension Height

The height at which the components of a particular vehicle should be set when driveline angle measurements are made.

Deceleration

Slowing of vehicle by releasing foot from accelerator at cruise and allowing engine to slow vehicle without application of brakes.

Driveline Angle

Alignment of the transmission output shaft, driveshaft, and rear axle pinion centerline.

Driveshaft (Propeller Shaft/Propshaft)

Rearmost shaft of a driveline which powers the rear axle input shaft (pinion shaft).

GLOSSARY OF TERMS (Continued)

Drivetrain

Includes all power transmitting components from the engine to the wheels, including clutch/torque converter, transmission, driveline and rear drive axle.

Engine Run-up Test

Operation of engine through normal rpm range with vehicle sitting still, transmission in Neutral. Used for engine and accessory vibration check.

Engine Misfire

One or more cylinders in the engine fails to fire at the proper time.

Engine Imbalance

Some component in the engine which is normally smoothly balanced now causing a perceptible vibration in the vehicle.

Flat Spots (Tires)

Commonly caused by letting vehicle stand while tires cool off. Can be cured by again operating vehicle until tires are warm. Also, regular tire wear patterns in the tire tread resulting from wheel-locked skids.

Float

A cruising drive mode in which throttle setting matches engine speed to road speed, resulting in very gradual deceleration.

Gravelly Feel

A grinding or growl in a component, similar to the feel experienced while driving on gravel.

Harshness

A harder than usual behavior of a component, like riding a vehicle with over-inflated tires.

Hz

Hertz (Cycles Per Second).

Imbalance (or Unbalance)

Out of balance; more weight on one side of a rotating component causing shake or vibration.

Inboard

Toward the centerline of the vehicle. (See Outboard).

Isolate

Separate from the influence of other components.

NVH

Noise, Vibration, Harshness.

Neutralize (Normalize)

To return to unstressed position. Used to describe various mounts and exhaust system hangers (See Bound Up).

Outboard

Toward the outside of the vehicle, rather than toward the centerline (See inboard).

Phase

Referring to the rotational positions of the various elements of a driveline.

Pinion Shaft

The input shaft to a driving axle, usually a part of the smaller driving or input gear of a "Ring and Pinion" gear set.

Pumping Feel

A very slow vibration that results in a movement of vehicle components similar to pumping the service brakes slightly.

Radial/Lateral

Radial is in the plane of rotation, lateral is at 90° to the plane of rotation.

Ring Gear

The large gear, driven by the pinion gear of a "Ring and Pinion" driving axle gear set. Not applicable to transaxle.

Road Test

Operation of vehicle under conditions designed to recreate the problem condition.

Runout

Out-of-round or wobble.

Shake

Low-frequency vibration, usually results in visual movement of components.

Slip Yoke (Slip Spline)

Driveshaft coupling device (1/2 of a U-joint) which compensates for changes in shaft length due to articulation of axle; used at one end of driveshaft.

Tires—Flat Spots

Commonly caused by letting vehicle stand when tires are warm. Can be cured by operating vehicle until tires are warm.

Tire Force Vibration

Tire vibration caused by vibrations in the construction of the tire, resulting in a vibration when the tire rotates against the pavement. This condition may be present on perfectly round tires because of variations in the inner construction.

Two-plane Balance

Radial and lateral balance.

Tire Deflection

Bending of the body of the tire during rotation.

TIR

Total Indicator Runout.

Tip-in Moan

A light moaning noise heard when the vehicle is lightly accelerated usually between 40 to 80 km/h (25 to 50 mph).

Vibration

Regular movement of a component that results in a sound or feel of movement.

ENGINE

GROUP 21 (6000)

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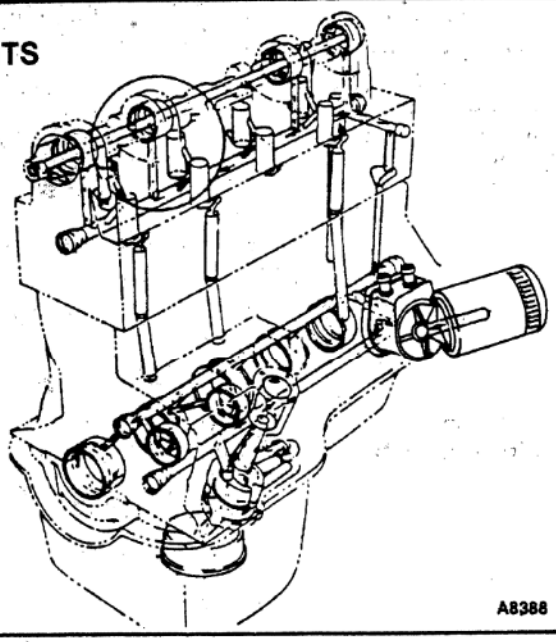
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GENERAL INFORMATION

This section addresses diagnostic procedures on the base engine. Where additional causes could be responsible for a given condition, they will be referred to that section of the manual. The section is divided into two parts.

- Troubleshooting Charts—The engine conditions that are included in this part include engine misfiring, low power, stalling, noises, smoking, high fuel consumption, etc., or conditions that a driver or operator would recognize as abnormal.
- Diagnostic Procedures—The purpose of the procedures is to confirm the causes of the conditions perceived by the driver/operator or technician.

TROUBLESHOOTING CHARTS

ENGINE CONDITIONS

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine will not crank	Hydrastatic (hydraulic) lock in cylinders	Remove spark plugs and rotate engine with a wrench. Spark plug removal is covered in Section 23-01.
	Seized piston(s)	Remove cylinder head and oil pan. Refer to Base Procedures 23 and 26 in Section 21-05. Attempt to rotate engine with a wrench. Look for non-moving piston. Remove piston(s) as necessary.

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TROUBLESHOOTING CHARTS

ENGINE CONDITIONS (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine will not crank (Continued)	Broken crankshaft or connecting rod	Remove oil pan and parts as necessary. Refer to Base Procedure 26 in Section 21-05.
	Starter locking flywheel	Remove starter. Refer to Section 28-01 or 28-02.
	Flywheel damaged	Inspect flywheel. Refer to Base Procedure 28 in Section 21-05.
	Starting system	Refer to Section 28-01.
Engine cranks but will not start	Low compression	Check compression. Refer to Diagnostic Procedures in this section.
	Camshaft out of time	Refer to Base Procedure 2, Section 21-05.
	Ignition system	Refer to Section 23-01.
	Fuel system	Refer to Section 24-01.
Engine starts but fails to stay running	Fuel system	Refer to Section 24-01.
	Idle speed set too low	Refer to Diagnostic Procedures in this section.
	Ignition system	Refer to Section 23-01.
	Exhaust system restricted	Refer to Section 26-01.
	Loose intake manifold or damaged gasket	Perform intake manifold Vacuum Test. Refer to Diagnostic Procedures in this section. Removal and Installation of manifold is covered in Section 24-29.
Engine runs but misfires	Sticking intake or exhaust valve(s)	Perform an Intake Manifold Vacuum Test. Refer to Diagnostic Procedures in this section. Remove cylinder head and valves. Clean and inspect valve stems and guides. Refer to Base Procedure 23 and to Cleaning, Inspection and Overhaul in Section 21-05.

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TROUBLESHOOTING CHARTS

ENGINE CONDITIONS (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine runs but misfires (Continued)	Weak or broken valve spring(s)	Perform an Intake Manifold Vacuum Test. Refer to Diagnostic Procedures in this section. Inspect valve springs. Refer to Base Procedure 11 and to Cleaning, Inspection and Overhaul in Section 21-05.
	Loose intake manifold	Perform an Intake Manifold Vacuum Test. Refer to Diagnostic Procedures in this section. Removal and Installation of manifold is covered in Section 24-29.
	Ignition system	Refer to Section 23-01.
	Fuel system	Refer to Section 24-01.
Rough engine idle	Engine compression low	Test compression. Refer to Diagnostic Procedures in this section.
	Intake or exhaust valves leaking	Perform Intake Manifold Vacuum Test. Refer to Diagnostic Procedures in this section.
	Worn camshaft lobes	Inspect camshaft. Refer to Cleaning, Inspection and Overhaul in Section 21-05.
	Loose or worn engine mounts	Refer to Engine Removal and Installation in Section 21-05.
	Intake manifold or gasket loose or damaged	Perform Intake Manifold Vacuum Test. Refer to Diagnostic Procedures in this section. Removal and Installation of manifold is covered in Section 24-29.
	Fuel system	Refer to Section 24-01.
	Ignition system	Refer to Section 23-01.
Poor acceleration	Engine compression low	Test compression. Refer to Diagnostic Procedures in this section.
	High engine friction	Continue engine break-in.
	Valve timing incorrect	Perform Base Procedure 2, and if necessary, Base Procedure 3 in Section 21-05.

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TROUBLESHOOTING CHARTS

ENGINE CONDITIONS (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Poor acceleration (Continued)	Fuel system	Refer to Section 24-01.
	Ignition system	Refer to Section 23-01.
	Brakes dragging	Refer to Section 21-01.
	Automatic transmission	Refer to Section 17-01.
	Vehicle overloaded	Test with vehicle unloaded or trailer disconnected.
	Turbocharger	Test with vehicle unloaded. Refer to Section 24-01.
	High-altitude or high-ambient temperature	Normal to loose some acceleration and power.
Low power or poor high-speed performance	Engine compression low	Test compression. Refer to Diagnostic Procedures in this section.
	Worn camshaft lobes	Inspect camshaft. Refer to Cleaning, Inspection and Overhaul in Section 21-05.
	Fuel system	Refer to Section 24-01.
	Ignition system	Refer to Section 23-01.
	Automatic transmission	Refer to Section 17-01.
	Turbocharger	Refer to Section 24-01.
	Exhaust system	Refer to Section 26-01.
Engine overheats	Defective thermostat	Refer to Section 27-01.
	Loose water pump drive belt	Refer to Section 27-01 or 27-02.
	Restricted coolant passages in cylinder block, cylinder head or radiator	Refer to Section 27-01.
	Obstructed radiator air flow	Clean with water or compressed air.
	Blown cylinder head gasket or cracked cylinder head or block	Test compression. Refer to Diagnostic Procedures in this section.
	Engine cooling or A/C fan(s) not operating	Refer to Section 27-01.
	Defective water pump	Refer to Base Procedure 8 in Section 21-05 and Section 27-01.
	Lower radiator hose collapsed	Refer to Section 27-01.
	Retarded ignition timing	Refer to Section 23-01.

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TROUBLESHOOTING CHARTS

ENGINE CONDITIONS (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine overheats (Continued)	Camshaft timing incorrect	Refer to Base Procedure 2, Section 21-05.
	Low coolant level	Add coolant.
	Frozen coolant	Thaw and refill with correct coolant mixture.
	Restricted exhaust system	Refer to Section 26-01.
	Defective temperature gauge or sending unit	Refer to Section 27-01.
Engine runs too cold	Defective or missing thermostat	Refer to Section 27-01.
	Incorrect thermostat—low temperature setting	Refer to Section 27-01.
Low oil pressure	Low oil level	Add oil.
	Diluted or wrong oil	Change oil and filter.
	Sending unit	Install master mechanical gauge in sending unit location and check pressure.
	Worn camshaft, main or connecting rod bearings or journals	Refer to Cleaning, Inspection and Overhaul or appropriate Base Procedure in Section 21-05.
	Worn or clogged oil pump or pump drive shaft worn	Refer to Cleaning, Inspection and Overhaul in Section 21-05.
	Oil pump relief valve stuck open	Remove pump, disassemble and inspect. Refer to Base Procedure 27 and to Cleaning, Inspection and Overhaul in Section 21-05.
Excess fuel consumption	Engine compression low	Test compression. Refer to Diagnostic Procedures in this section.
	Worn camshaft lobes	Inspect camshaft. Refer to Cleaning, Inspection and Overhaul in Section 21-05.
	Fuel system	Refer to Section 24-01.
	Ignition system	Refer to Section 23-01.
	Exhaust system	Refer to Section 26-01.
	Front wheel alignment and tire pressure	Refer to Section 14-01.

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TROUBLESHOOTING CHARTS

TROUBLESHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Excess fuel consumption (Cont'd)	Brakes dragging	Refer to Section 12-01.
	Automatic transmission	Refer to Section 17-01.
	Engine temperature too cold	Refer to Section 27-01.
Engine smoking blue-gray	Excess lube oil in cylinder(s) from poorly sealing piston rings or valve guides	Test compression. Perform cylinder leak test. Refer to Diagnostic Procedures in this section.
Engine smoking gray-white	Automatic transmission control diaphragm leaking	Refer to Section 17-01.
	Water or antifreeze in cylinders	Test compression. Perform cylinder leak test. Refer to Diagnostic Procedures in this section.
Engine smoking black-dark gray	Excess fuel in cylinder(s) or insufficient air to cylinders	Refer to Section 24-01.
Excess oil consumption	Engine break-in period not complete	Vehicle must be run for first 2,000 miles but not more than 4,000.
	Oil viscosity too low or diluted	Change oil to proper viscosity and change oil filter.
	Oil level too high	Drain to proper level.
	Worn or stuck piston rings or worn cylinder walls. Incorrectly installed piston rings	Check engine compression and air leak. Check cylinders. Refer to Cleaning, Inspection and Overhaul in Section 21-05.
	Worn valve guides, stems or seals	Check valve stem to guide clearances. Air check crankcase and valve seals.
	Worn engine bearings	Check bearing clearances. Refer to Cleaning, Inspection and Overhaul and Base Procedures 28 and 31 in Section 21-05.
	Engine oil leaks	Refer to Diagnostic Procedures in this section.

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TROUBLESHOOTING CHARTS

ENGINE RELATED NOISES

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Miscellaneous noises: grinding, scraping, howling, squeaking and rattles	Many noises are located in or caused by the engine accessories such as the alternator, A/C compressor, water pump, power steering pump or cooling fan	Remove the drive belts and run the engine for a short time. Do not overheat the engine. Refer to Base Procedures 5R & I in Section 21-05. Also, refer to Section 27-02.
	The exhaust system and transmission are also possible noise sources	Refer to Sections 26-01, 16-01 and 17-01.
Light tapping at one-half engine speed and non-varying frequency	Excessive valve train clearance at cam follower, valve stem, hydraulic lash adjuster or camshaft lobe(s)	Refer to Diagnostic Tests and to Cleaning, Inspection and Overhaul in Section 21-05.
Light tapping as above but with varying frequency—comes and goes	Sticking valve(s) or hydraulic lash adjusters	Perform compression and manifold vacuum tests. Refer to Diagnostic Procedures in this section. Also, refer to Cleaning, Inspection and Overhaul in Section 21-05.
Light to medium rap; most noticeable when engine is cold and at mid-range of engine speed. Noise temporarily reduced when oil is added to affected cylinder	Excess piston to cylinder bore clearance (piston slap)	Measure piston to bore clearance. Refer to Base Procedure 29 and to Cleaning, Inspection and Overhaul in Section 21-05.
Light to medium double rap each engine revolution. More noticeable at engine idle. Shorting out the affected cylinder increases noise	Excess piston-to-piston pin clearance	Measure piston-to-piston pin clearance. Refer to Base Procedure 29 and to Cleaning, Inspection and Overhaul in Section 21-05.
Medium-to-heavy sharp knock at medium engine speed and at a no load or "float" condition. Shorting out cylinder reduces noise	Connecting rod bearing(s)-to-crankshaft clearance excessive	Measuring connecting rod bearing clearance. Refer to Base Procedure 29 and to Cleaning, Inspection and Overhaul in Section 21-05.
Heavy, dull knock or thud at any engine speed. More severe unde load. Sound will change when spark plug is shorted in area of worn bearing	Main bearing-to-crankshaft clearance excessive	Measure main bearing clearance. Refer to Base Procedure 30 and to Cleaning, Inspection and Overhaul in Section 21-05.

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TROUBLESHOOTING CHARTS

ENGINE RELATED NOISES (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Heavy, dull knock or thud. Manual transmission clutch operation will change noise. Automatic transmission stall condition will increase noise	Flywheel loose or cracked	Inspect flywheel for cracks and secure attachment. Refer to Base Procedure 28 in Section 21-05.
Light ping or sharp clank depending on throttle opening, engine speed and loading. Lower engine speeds and heavier loading produce louder knock	Detonation or spark knock caused by combination of high advanced spark timing, low octane fuel, high engine temperature, high engine loading at low engine speeds, high compression, carboned engine and high ambient temperature. Other reasons for detonation are hot spots in the cylinder, spark plug heat range too hot or lean fuel mixture	Refer to Section 23-01.
Dieseling or engine running after ignition is shut off	High idle speed	Lower idle speed to specification. Refer to Diagnostic Procedures in this section.
	Low octane fuel	Change fuel to specified fuel.
	Excess carbon in combustion chambers	Clean carbon.
	Hot spots in combustion chamber such as sharp valve edge, too hot a spark plug, heat range or glowing carbon	Clean combustion chamber or source of hot spot. Change spark plugs to proper heat range.
	Intake system air leak	Test intake manifold vacuum. Refer to Diagnostic Procedures in this section.

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DIAGNOSTIC PROCEDURES

INTAKE MANIFOLD VACUUM TEST

Bring the engine to normal operating temperature. Connect vacuum gauge to the intake manifold. Run engine at specified idle speed.

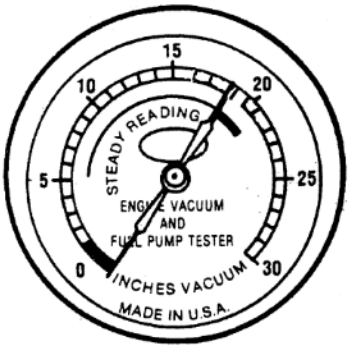
The vacuum gauge should read between 15 and 22 inches depending upon the engine condition and the altitude at which the test is performed. SUBTRACT ONE INCH FROM THE SPECIFIED READING FOR EVERY 1,000 FEET OF ELEVATION ABOVE SEA LEVEL.

The reading should be quite steady. It may be necessary to adjust the gauge damper control (where used) if the needle is fluttering rapidly. Adjust damper until needle moves easily without excessive flutter.

Interpreting Vacuum Gauge Readings

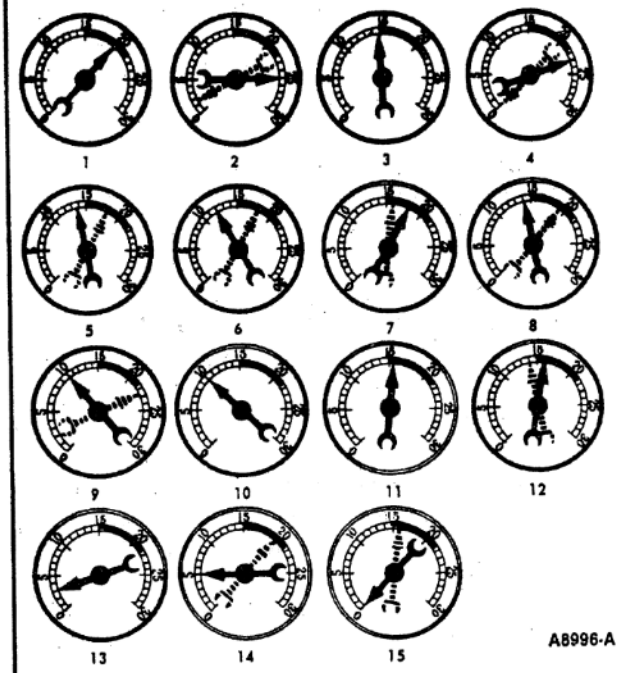
A careful study of the vacuum gauge reading while the engine is idling will help to pinpoint trouble areas. Always conduct other appropriate tests before arriving at a final diagnostic decision. Remember that vacuum gauge readings, although helpful, must be interpreted with care.

Most vacuum gauges have a "normal" band indicated on the gauge face.



A8995-A

Following are potential gauge readings. Some should be considered as normal; others should be investigated further.



A8996-A

1. NORMAL READING: Needle between 15 and 22 inches and holding steady.
2. NORMAL READING DURING RAPID ACCELERATION AND DECELERATION: When engine is rapidly accelerated (dotted needle) needle will drop to a low (not to 0) reading. When throttle is suddenly released, the needle will snap back up to a higher than normal figure.

NOTE: The rapid acceleration and deceleration must be done very quickly by hand to avoid turbocharger boost.

3. NORMAL FOR HIGH LIFT CAM WITH LARGE OVERLAP: Needle will register as low as 15 inches but will be relatively steady. Some oscillation is normal.
4. WORN RINGS OR DILUTED OIL: When engine is accelerated (dotted needle) needle drops to 0 inch. Upon deceleration, needle runs slightly above 22 inches.
5. STICKING VALVE OR VALVES: When the needle (dotted) remains steady at a normal vacuum but occasionally flicks (sharp, fast movement) down and back about 4 inches, one or more valves may be sticking.

DIAGNOSTIC PROCEDURES

INTAKE MANIFOLD VACUUM TEST (Continued)

6. BURNED OR WARPED VALVES: A regular, evenly spaced downscale flicking of the needle indicates one or more burned or warped valves. Insufficient hydraulic lash adjuster clearance will also cause this action.
7. POOR VALVE SEATING: A small but regular downscale flicking can mean one or more valves are not seating.
8. WORN VALVE GUIDES: When the needle oscillates (swings back and forth), over about a 4-inch range at idle speed, the valve guides could be worn. As engine speed is increased, needle will become steady if guides are responsible.
9. WEAK VALVE SPRINGS: When the needle oscillation becomes more violent as engine rpm is increased, weak valve springs are indicated. The reading at idle could be relatively steady.
10. LATE VALVE TIMING: A steady but low reading could be caused by late valve timing.
11. IGNITION TIMING RETARDING: Retarded ignition timing will produce a steady but somewhat low reading.
12. INSUFFICIENT SPARK PLUG GAP: When plugs are gapped too close, a regular, small pulsation of the needle can occur.
13. INTAKE LEAK: A low, steady reading, can be caused by an intake manifold or throttle body mounting flange gasket leak.
14. BLOWN HEAD GASKET: A regular drop of fair magnitude can be caused by a blown head gasket or warped head to block surface.
15. CLOGGED EXHAUST SYSTEM: When the engine is first started and is idled, the reading may be normal but as the engine rpm is increased, the back pressure caused by a clogged muffler, kinked tail pipe, etc., will cause the needle to slowly drop to 0. The needle then may rise slowly. Excessive exhaust clogging will cause the needle to drop to a low point even if the engine is only idled.

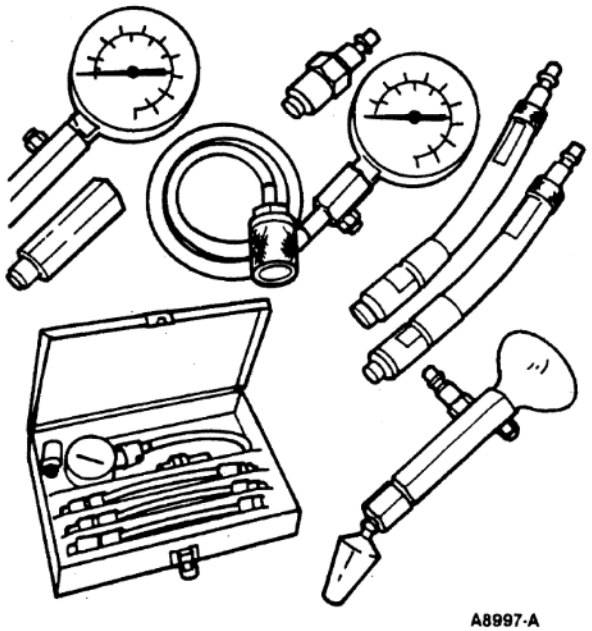
When vacuum leaks are indicated, search out and correct the cause. Excess air leaking into the system will upset the fuel mixture and cause trouble such as rough idle, missing on acceleration, burned valves. If the leak exists in some accessory unit, such as the power brake, the unit will not function correctly. ALWAYS FIX VACUUM LEAKS.

ENGINE COMPRESSION TEST

Operate the engine until normal operating temperature is reached. Remove the spark plugs (see Section 23-02 for correct removal and installation technique). Remove the air cleaner. Block the throttle body valve in the wide open position.

Ground the distributor end of the coil secondary wire. Attach a remote starter switch.

Insert a compression gauge TIGHTLY in the spark plug hole one at a time.



A8997-A

DIAGNOSTIC PROCEDURES (Continued)

Crank the engine (battery must be fully charged, in good condition and properly connected). Starter must spin engine as specified until the gauge shows no further rise in pressure, (this will require at least 4 or 5 COMPRESSION strokes).

Normally, the first compression stroke will run the gauge indicator needle a considerable distance up the scale. Succeeding strokes will raise it more until the highest level is shown. Record the highest reading for each cylinder.

For engines having plug holes that are difficult to reach, a compression gauge having an offset tip or one utilizing a flex hose, is useful.

Remember, that the engine must be at operating temperature and the throttle body valves must be open.

Interpreting Compression Readings

Examine the readings for all cylinders. Pressure variation between the highest and lowest cylinders should be within 75 percent of one another. Example: if the highest cylinder reads 134 psi and the lowest cylinder reads 101 psi, then the 101 reading is within 75 percent of the 134 reading.

Maximum PSI	Minimum PSI	Maximum PSI	Minimum PSI	Maximum PSI	Minimum PSI	Maximum PSI	Minimum PSI
134	101	164	123	194	145	224	168
136	102	166	124	196	147	226	169
138	104	168	126	198	148	228	171
140	105	170	127	200	150	230	172
142	107	172	129	202	151	232	174
144	108	174	131	204	153	234	175
146	110	176	132	206	154	236	177
148	111	178	133	208	156	238	178
150	113	180	135	210	157	240	180
152	114	182	136	212	158	242	181
154	115	184	138	214	160	244	183
156	117	186	140	216	162	246	184
158	118	188	141	218	163	248	186
160	120	190	142	220	165	250	187
162	121	192	144	222	166		

A8998-A

DIAGNOSTIC PROCEDURES (Continued)

Variations between cylinders will have a greater effect upon engine performance than overall readings that are even but slightly below specifications.

When taking compression readings, watch the action of the gauge needle. When it raises only a small amount on the first stroke and little more on succeeding strokes, ending up with a very LOW reading, burned, warped or sticky valves are indicated.

A low buildup on the first stroke with a gradual buildup on succeeding strokes, to a moderate reading, can mean worn, stuck or scored rings.

If two adjacent cylinders are low, a blown head gasket or warped head to block surface could be responsible.

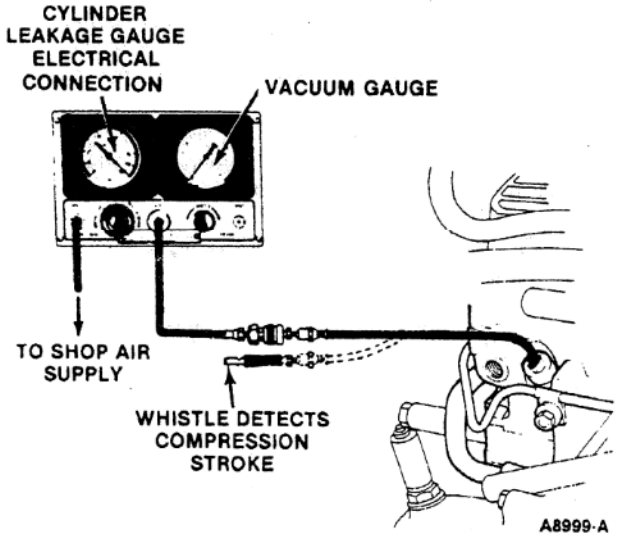
Add one tablespoon of heavy (30W minimum) engine oil to a cylinder with a low reading. Insert the compression gauge and recheck the cylinder. Crank the engine for a few extra compression strokes and watch the gauge. If the compression goes up 10 percent or more, worn rings are indicated. If the addition of the oil produces no significant change, valve trouble, a broken piston or a blown gasket, etc., is probably causing the low reading.

If the compression pressure exceeds specifications, there is a buildup of carbon on the head of the piston and on the combustion chamber walls. IF CARBON BUILDUP IS PRESENT, AND IS CAUSING PINGING THAT CANNOT BE STOPPED BY RETARDING THE TIMING, OR BY SWITCHING TO A HIGHER OCTANE GASOLINE, THE CARBON SHOULD BE REMOVED.

Hard cranking can indicate excessive compression from carbon buildup.

Cylinder Leakage Detector

When a cylinder produces a low reading, the use of a cylinder leakage detector will be helpful in pinpointing the exact cause.



The leakage detector is inserted in the spark plug hole, piston brought up to dead center on the compression stroke, and compressed air admitted.

Once the combustion chamber is pressurized, a special gauge will read the percentage of leakage. Leakage exceeding 20 percent is considered excessive.

While the air pressure is retained in the cylinder, listen for the hiss of escaping air. A leak by the intake valve will be audible in the throttle body. A leak by the exhaust valve can be heard at the tail pipe. Leakage past the rings will be audible, at the PCV (positive crankcase ventilation) connection. If air is passing through a blown gasket to an adjacent cylinder, the noise will be evident at the plug hole of the cylinder into which the air is leaking. Cracks in the block or gasket leakage into the cooling system may be detected by a stream of bubbles in the radiator.

DIAGNOSTIC PROCEDURES (Continued)

Oil Leak and Valve Guide Seal Test

The cylinder leakage detector can be used to test for engine oil leaks and to check the valve seals for leakage.

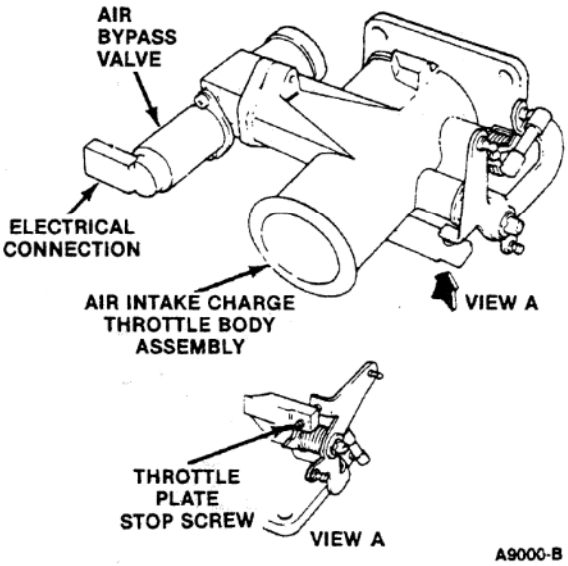
1. Plug all crankcase openings except the one used for connecting the leakage detector.
2. Connect the detector to a crankcase opening (oil dipstick tube is convenient) and adjust the air pressure to approximately 5 psi.
3. Using a solution of liquid soap and water, brush the solution along gasket sealing surfaces and bearing seals. Look for bubbles or foam.
4. Remove the spark plugs and rotate the engine slowly with a wrench. Check for large amounts of air escaping into the cylinders as each intake and exhaust valve opens.

   The spark plugs on the leaking cylinders will probably show deposits of burned oil.

Engine Idle Speed Test

The engine warm curb idle speed should be 900 rpm ±75.

1. To check idle speed, place the transmission in neutral and turn the A/C-blower switch to Off. Run the engine until it reaches normal operating temperature and then shut it off. Disconnect the air bypass valve electrical connection.
2. Connect a tachometer to the engine.
3. Start the engine. Check the throttle plate and linkage for sticking by tapping the throttle pedal until it opens approximately 1/4 of full travel and then release it. Repeat this procedure two or three times. Observe the tachometer to be sure it repeats the rpm reading. Correct sticking condition, if necessary, and recheck.
4. Operate the engine at 2000 rpm for two minutes.
5. If the electric cooling fan comes on during the checking procedure, disconnect it at the electrical connector.
6. Allow the engine to idle and observe the rpm. It should be 750 ±50 rpm. Adjust the idle rpm at the throttle plate stop screw.



7. Turn the engine off.
8. Connect the electrical connection to the cooling fan, if necessary.
9. Connect the electrical connection at the air bypass valve.
10. Recheck idle speed. It should now be 900 rpm ±75.

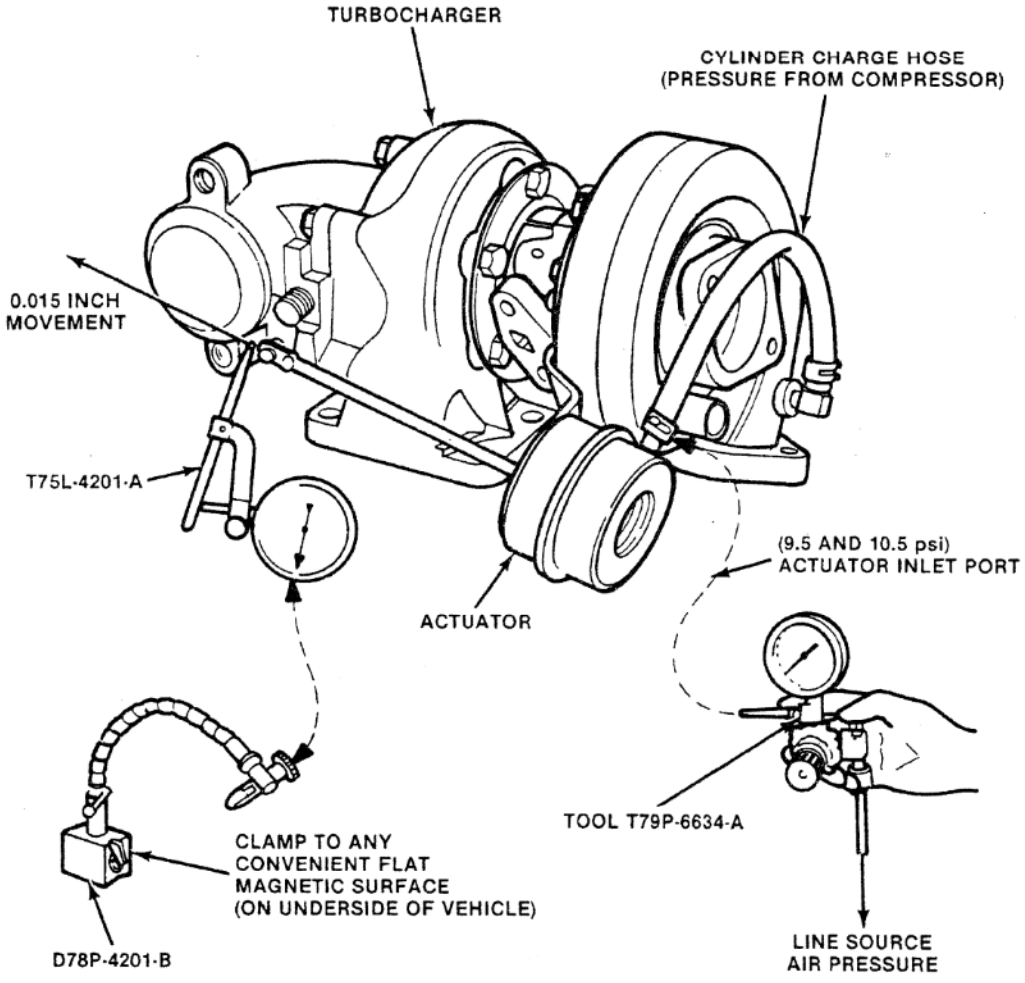
NOTE: If, after performing the above procedure, the curb idle is not within specification, it will be necessary to refer to Sections 23-01 and 24-01.

NOTE: If, while driving the vehicle at idle speed throttle position, the engine speed is too great, turn the ignition switch off until the engine has stopped. Restart the engine. If the speed is still excessive, do not drive the vehicle until the condition is repaired.

DIAGNOSTIC PROCEDURES (Continued)

Turbocharger Wastegate Function Test

1. Raise the vehicle and install a clutch housing alignment adapter (T75L-4201-A) fastened to a dial indicator with magnetic base (D78P-4201-B) at the end of the actuator and set the gauge to zero.
2. Connect a gauged air pressure line to the actuator inlet port. To get a gauged air pressure, use a combination air pressure regulator and air pressure dial (T79P-6634-A), connected to a source line (shop air supply).
3. Starting with zero air pressure, slowly increase the air pressure until the actuator arm moves about 0.38mm (0.015 inch). The pressure gauge should read betweem 32-35 kPa (9.5 and 10.5 psi).
4. If the reading is not within specification, or if no movement is measured at 10.5 psi, replace the turbocharger assembly.



SECTION 21-05 ENGINE

CONTENTS

NOTE: In this section the disassembly and assembly of the 2.3 liter, OHC engine is broken down into a series of individual procedures called base procedures. Each base procedure contains the separate steps required to remove or install a single component. Where necessary, a series of base procedures may have to be combined and completed before an actual component can be removed. In the disassembly portion of this section, the preliminary base procedures are listed before the removal steps. To install a component, refer to the corresponding assembly base procedure, complete the procedural steps and then, if necessary, complete the listed assembly base procedures.

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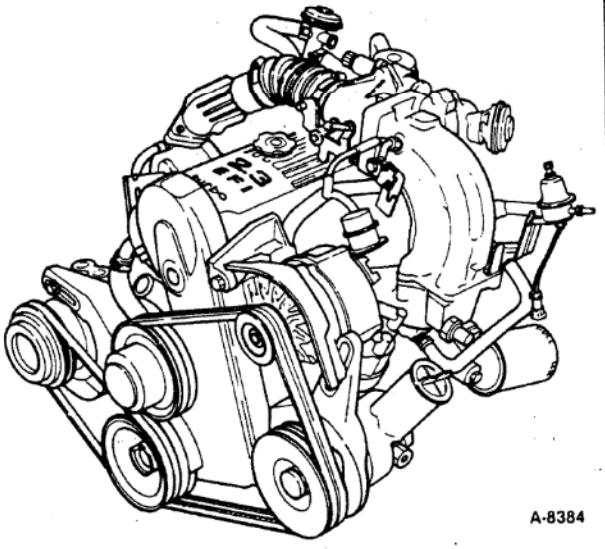
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CLEANING, INSPECTION AND OVERHAUL

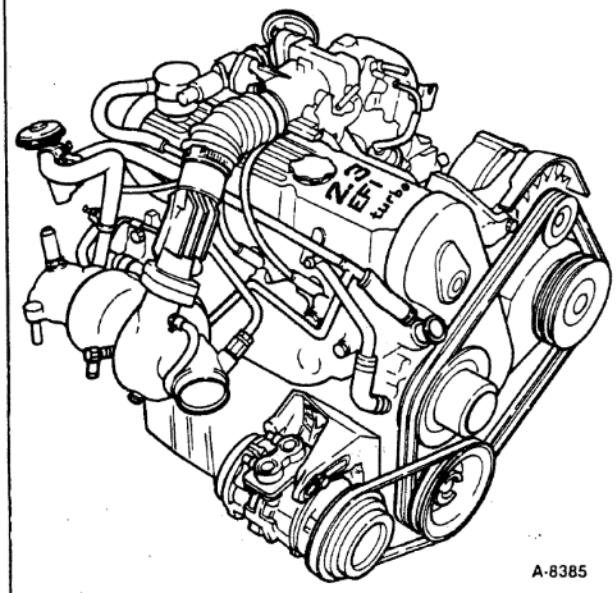
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DESCRIPTION

The 2.3L engine is a four cylinder, overhead cam (OHC) powerplant with electronically controlled fuel injection and the EEC IV engine control system. The engine is also equipped with a turbocharger which is attached to the exhaust manifold on the right side of the engine.

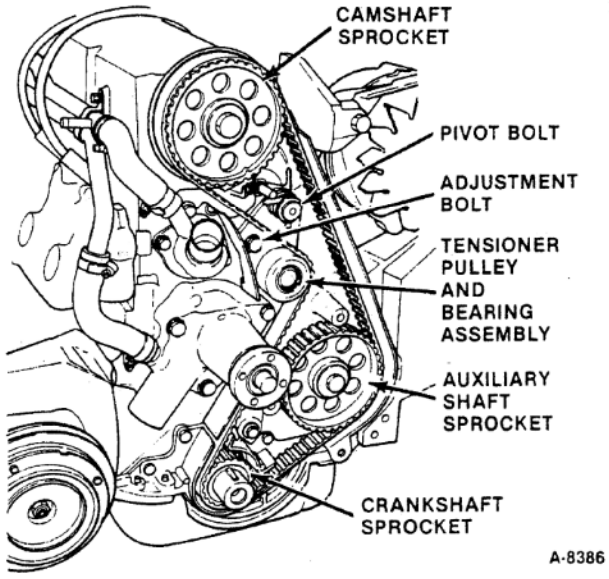


A-8384



A-8385

The engine foundation—cylinder head and block—is cast iron with the crankshaft and camshaft supported on bearing inserts. The crankshaft is supported in the cylinder block on five main bearings, while the camshaft is supported on four bearings in the cylinder head. A third shaft—the auxiliary shaft—is supported in the cylinder block on two bearing inserts. The crankshaft drives the camshaft and auxiliary shaft through a cogged belt installed over sprockets bolted to the end of each shaft. As the camshaft is driven, it will open and close the valves in the cylinder head. The function of the auxiliary shaft is to drive the distributor shaft and the oil pump. The auxiliary shaft drives the distributor shaft directly through a gear set. The oil pump is indirectly driven through the distributor shaft which is linked to the oil pump by a short hexagonal drive shaft. Tension on the drive belt is maintained by a spring-loaded tensioner pulley pressing against the outside of the belt.

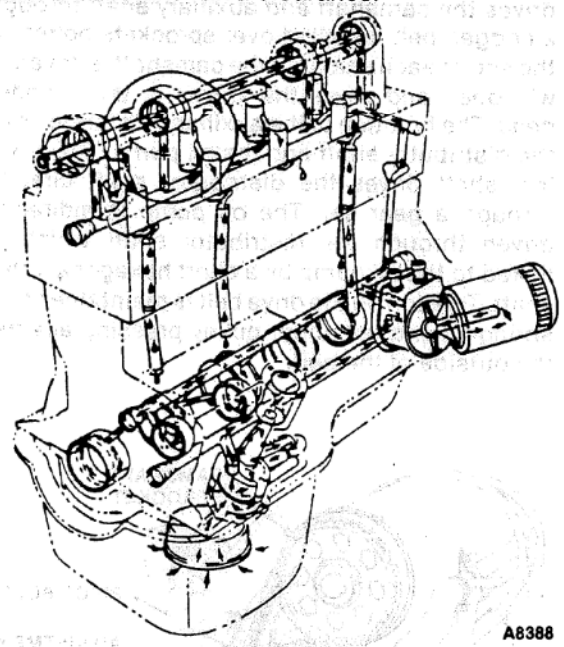


A-8386

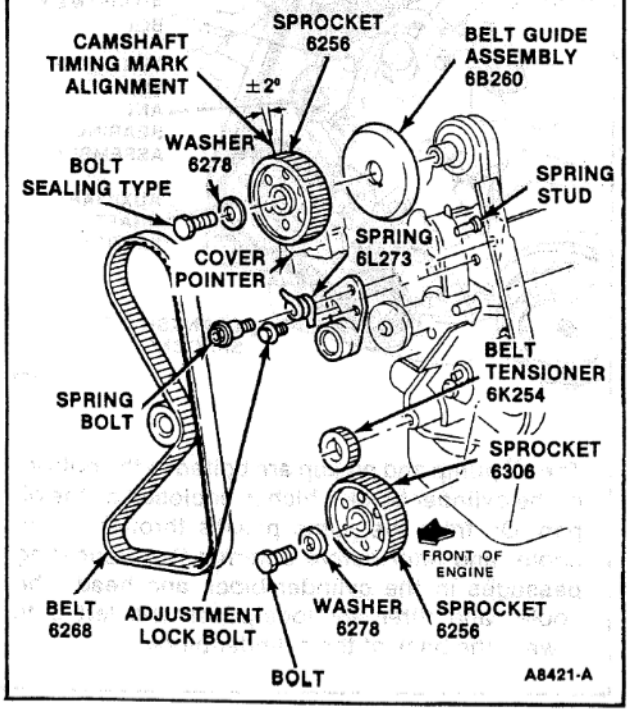
The oil pump and pickup are bolted to the bottom of the cylinder block which is enclosed by the oil pan. Oil from the pump passes through an oil cooler and filter before entering the lubricating passages in the cylinder block and head. The cooler and filter are located on the left side toward the back of the cylinder block.

DESCRIPTION

The entire valve train is located in the cylinder head. The cam is mounted above the valves, cam followers and lash adjusters. The cam followers are installed across the valve and lash adjuster in the form of a bridge with the cam lobes positioned above the fulcrum point. The lash adjusters are the hydraulic type that maintain a constant valve clearance.



A8388

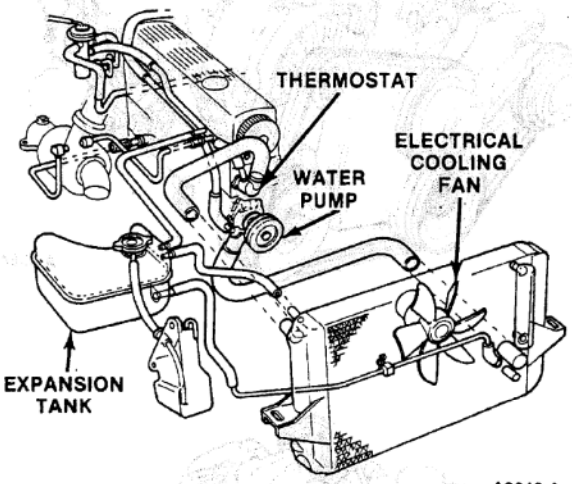


A8421-A

The water pump is separately driven from the crankshaft by two cogged V-belts which also drive the alternator and power steering pump. Coolant temperature is controlled by a thermostat, located in the water outlet housing at the front of the engine above the water pump.

A fan is not mounted on the water pump shaft. Instead, electric cooling fans are installed on the rear of the radiator and the front of the A/C condenser.

For details related to other engine systems such as ignition, cooling or fuel, refer to the appropriate section in this shop manual.



A9018-A

WARNING: To avoid the possibility of human injury or damage to the vehicle, do not operate the engine with the hood open until the fan has been first examined for possible cracks and separation.

REMOVAL AND INSTALLATION

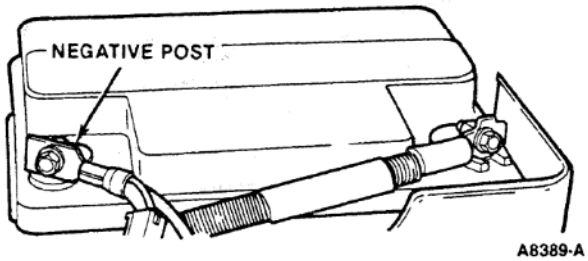
Engine Assembly

Removal

SPECIAL SERVICE TOOLS REQUIRED:

Vacuum Pump	D80P-250-A
Quick Connect Remover/Replacer	T82L-9500-AH

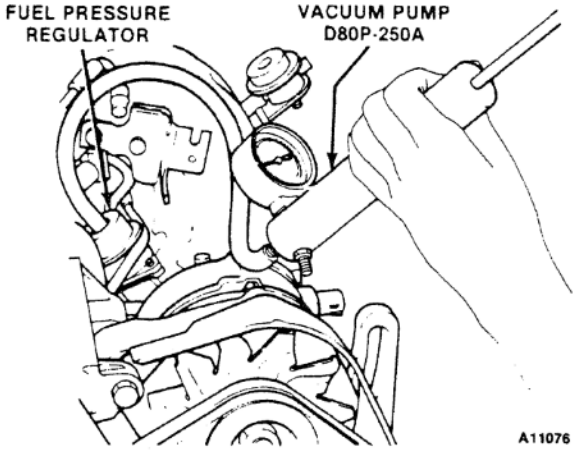
1. Open the hood and disconnect the battery negative cable.



2. Mark the hinge location and remove the hood. Make sure the ground strap near the right hinge is disconnected before removing the hood.

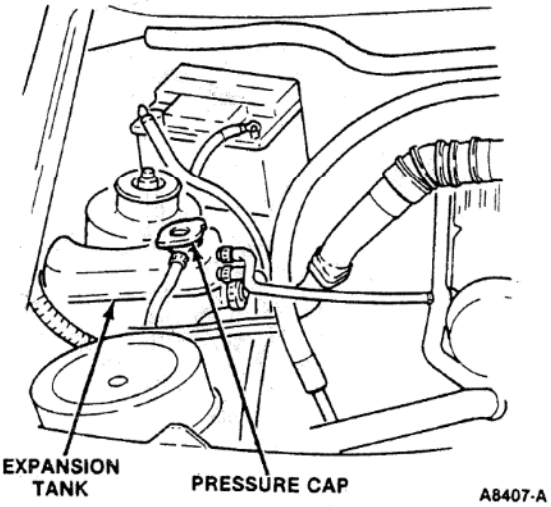
3. Depressurize the EFI fuel system using a hand-operated vacuum pump. Connect the pump hose to the fuel system pressure regulator and apply at least 25 inches of vacuum.

NOTE: It takes at least three minutes for the system to depressurize. If necessary, refer to the Fuel System Pressure Relief Procedure in Section 24-50.

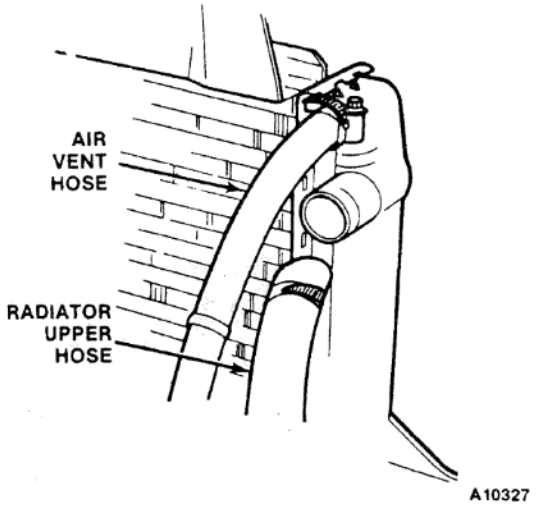


Use Vacuum Gauge D80P-250-A, or equivalent.

4. Remove the cap from the cooling system expansion tank and drain the radiator. If necessary, refer to Section 27-01 for the radiator drain location.



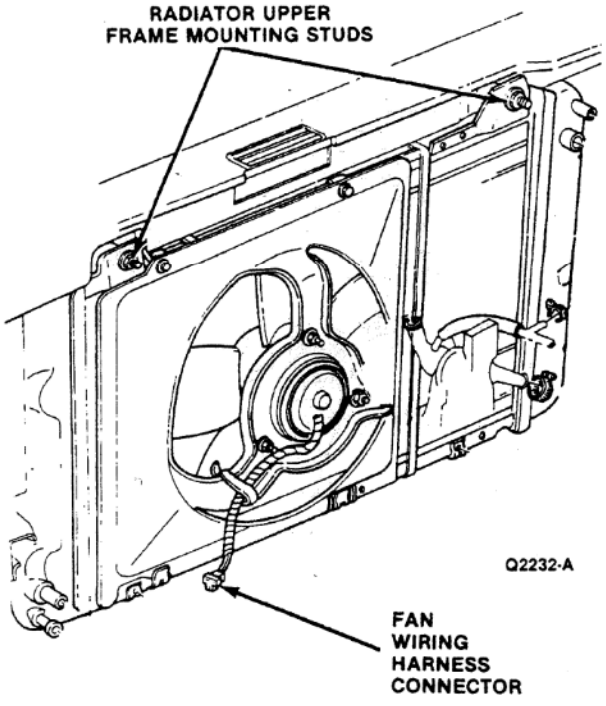
5. Disconnect the radiator upper hose at the radiator.



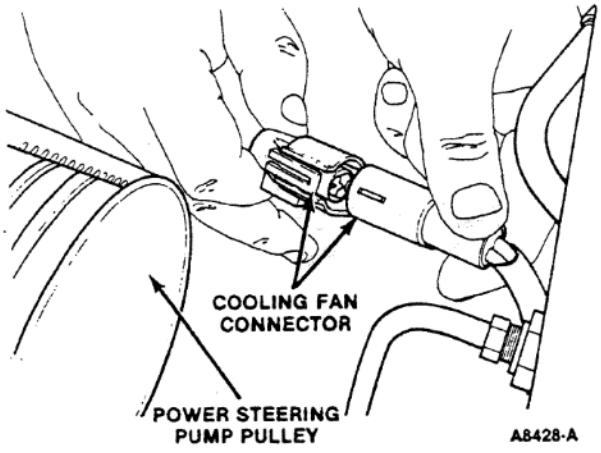
6. Disconnect the radiator air vent hose at the radiator (manual transmission only).

REMOVAL AND INSTALLATION (Continued)

7. Remove the radiator upper attaching bolts.

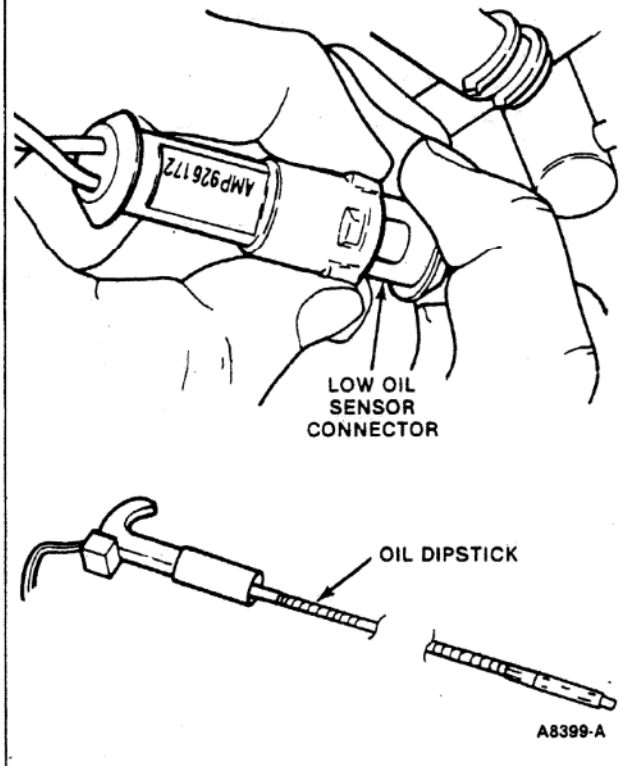


8. Disconnect the wiring at the cooling fan connector.



9. Separate the oil level sensor wiring connector and remove the engine oil level dipstick.

NOTE: Electrical connector at oil dipstick applies to all units bulit prior to 3-9-87.

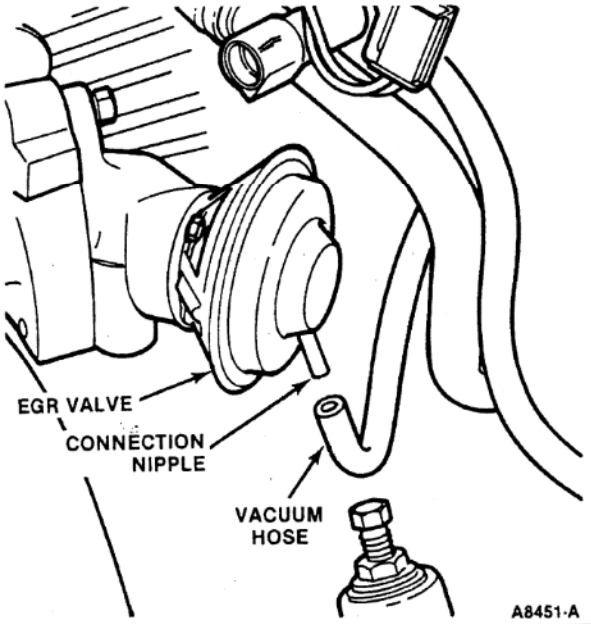


REMOVAL AND INSTALLATION

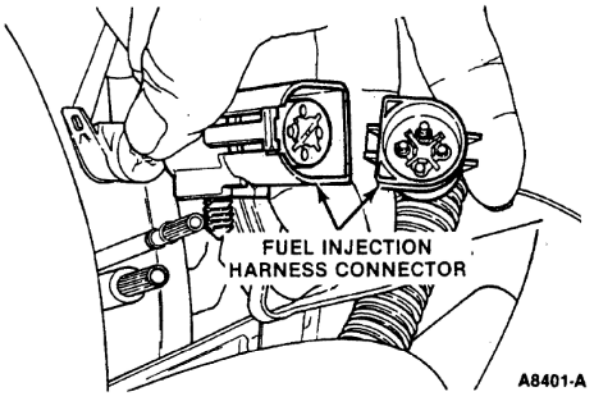
ENGINE ASSEMBLY

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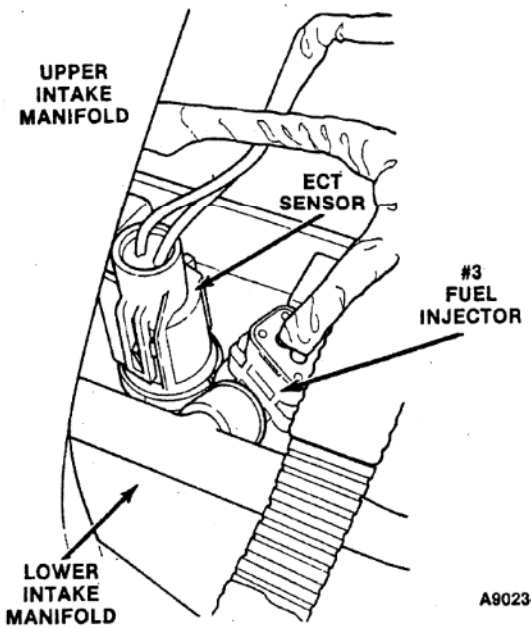
10. Disconnect the vacuum hose at the EGR valve.



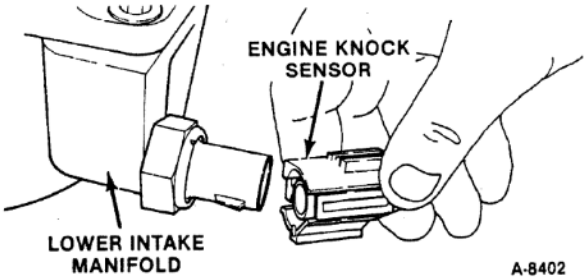
11. Separate the fuel injection wiring harness connector located between the upper intake manifold and the engine oil level dipstick.



12. Disconnect the wiring at the EEC IV engine coolant temperature sensor.



13. Disconnect the wiring at the engine knock sensor.

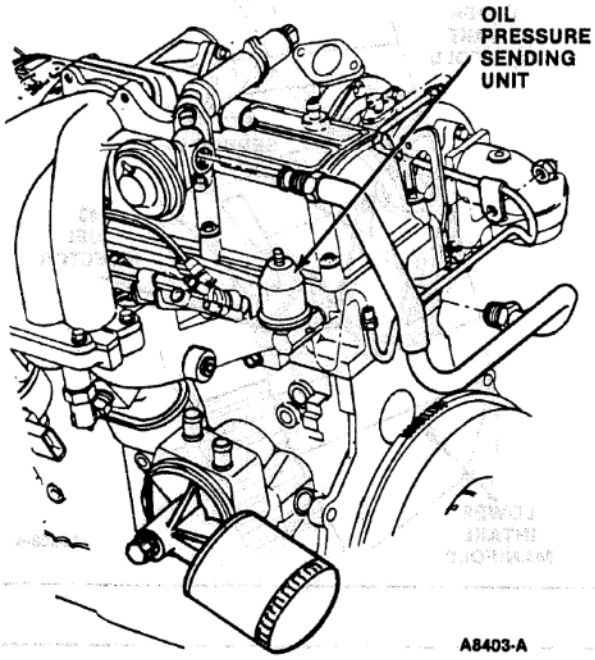


REMOVAL AND INSTALLATION

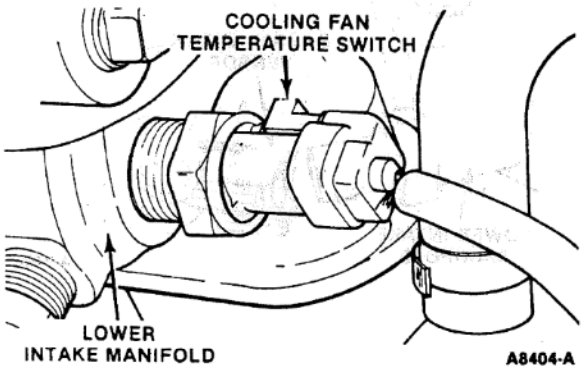
ENGINE ASSEMBLY

Removal (Continued)

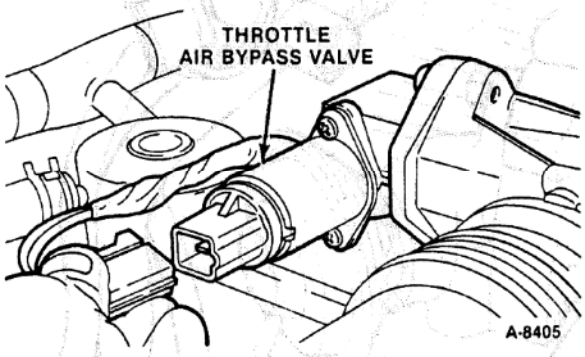
14. Disconnect the wire at the oil pressure sending unit.



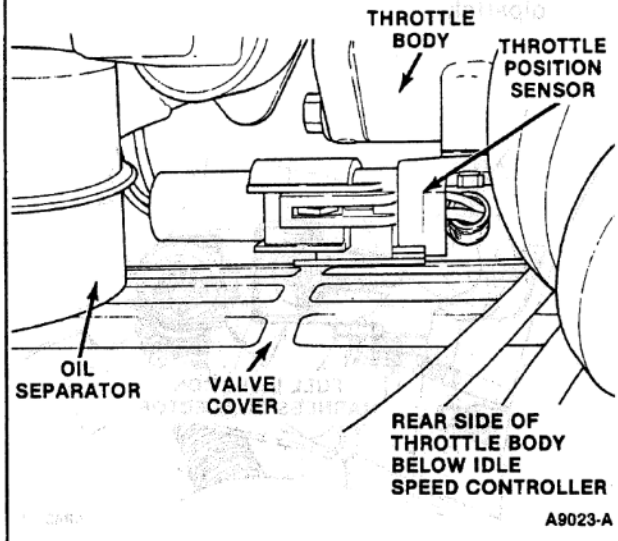
15. Disconnect the wires at the cooling fan temperature switch.



16. Disconnect the wires at the throttle air bypass valve.



17. Disconnect the wires at the throttle position sensor.

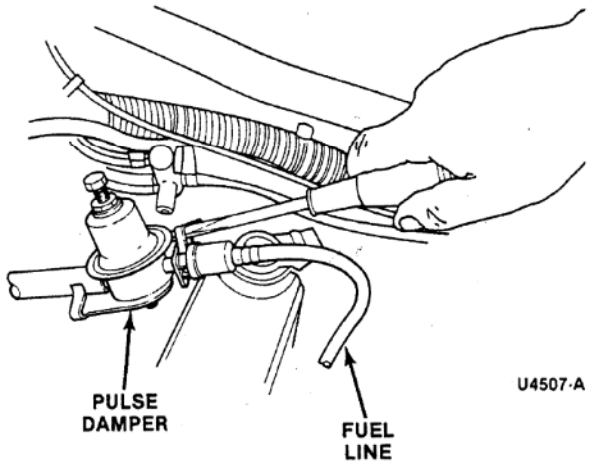


REMOVAL AND INSTALLATION

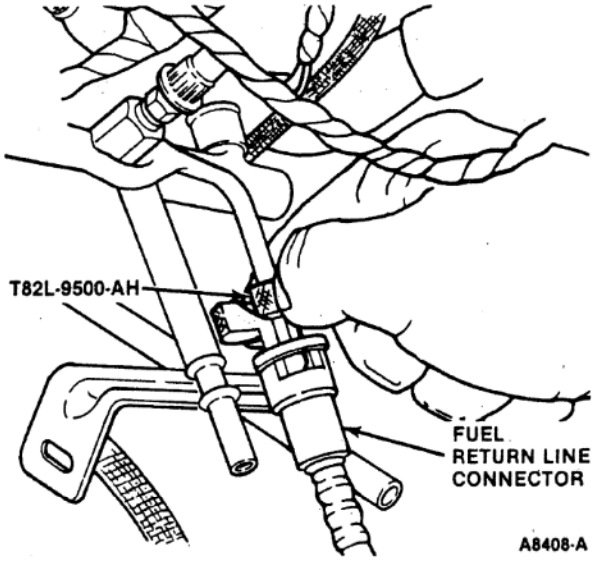
ENGINE ASSEMBLY

Removal (Continued)

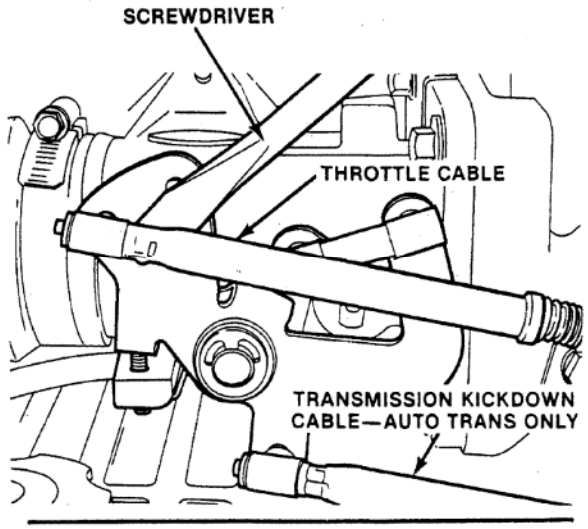
18. Disconnect the fuel line at the pulse damper.



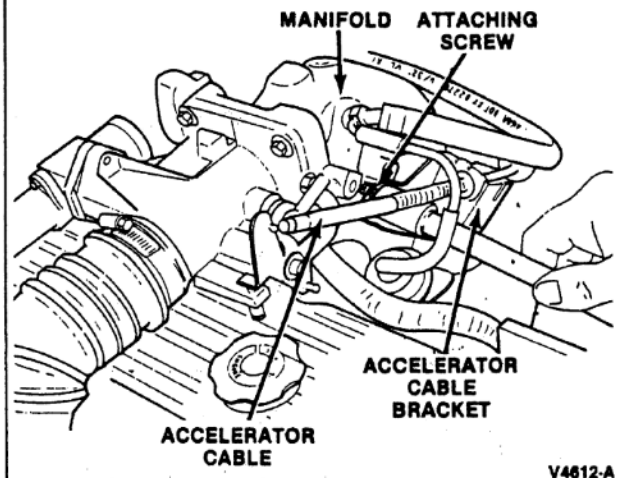
19. Disconnect the fuel return line using Quick Connect Remover/Replacer T82L-9500-AH, or equivalent.



20. Disconnect the throttle cable and, if equipped, the transmission kickdown cable.



Remove the accelerator cable bracket attaching screws and the bracket from the upper intake manifold. Place the bracket and the accelerator cable (and the automatic transmission kickdown cable, if so equipped) aside.

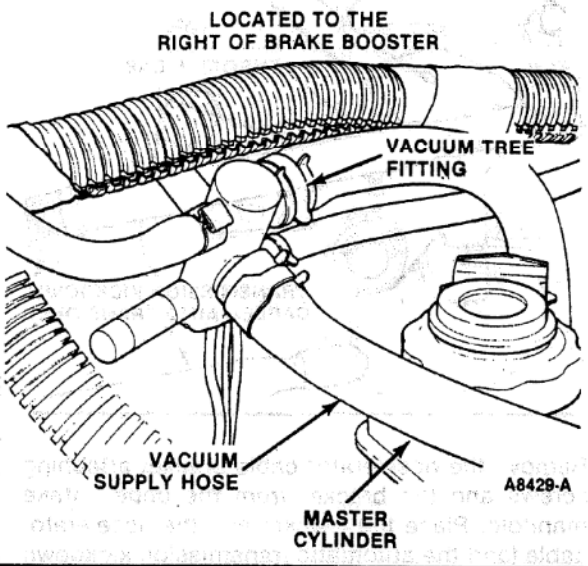


REMOVAL AND INSTALLATION

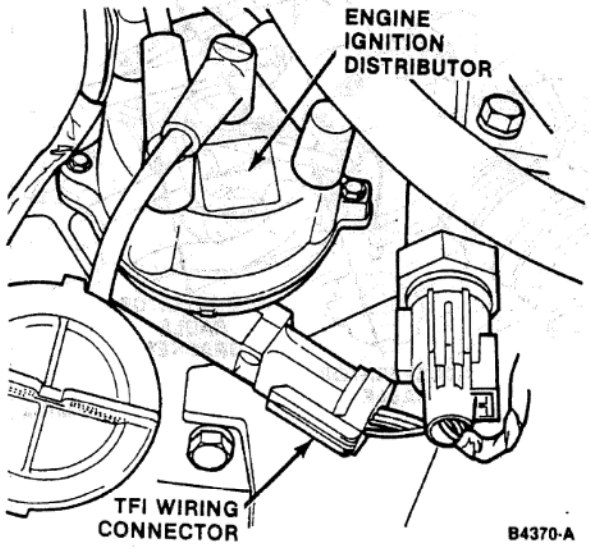
ENGINE ASSEMBLY

Removal (Continued)

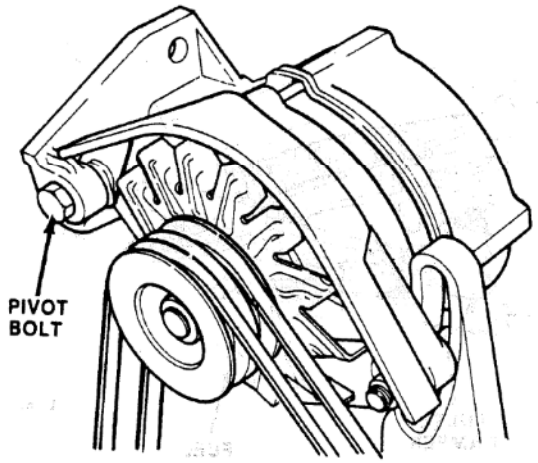
21. Disconnect the supply hose at the vacuum tree located on the dash panel.

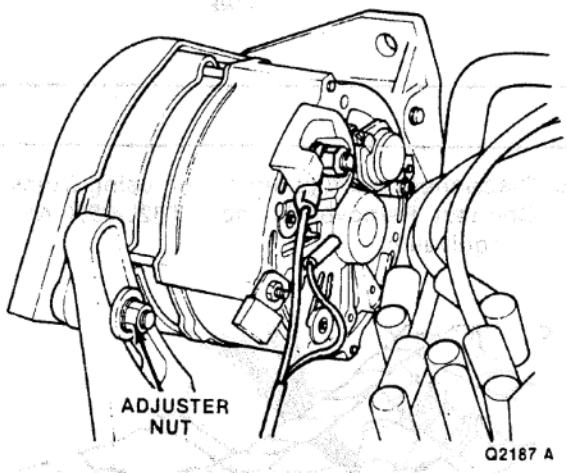


22. Disconnect the wiring at the distributor TFI module.



23. Remove the alternator from its mounting bracket and wire aside.





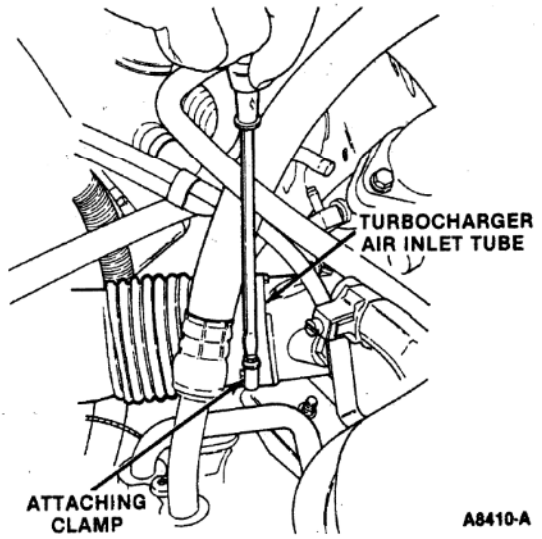
24. Remove the power steering pump from its mounting bracket and wire aside. If necessary, refer to Section 13-51.

REMOVAL AND INSTALLATION

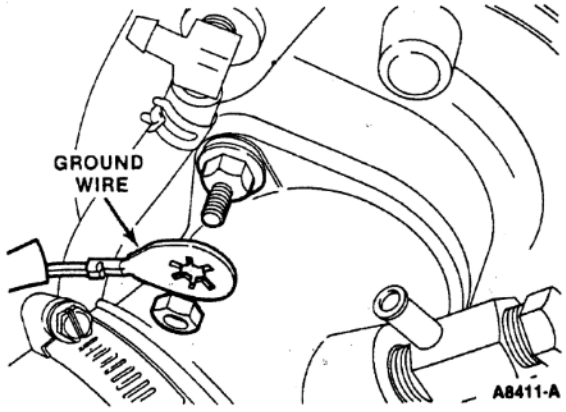
ENGINE ASSEMBLY

Removal (Continued)

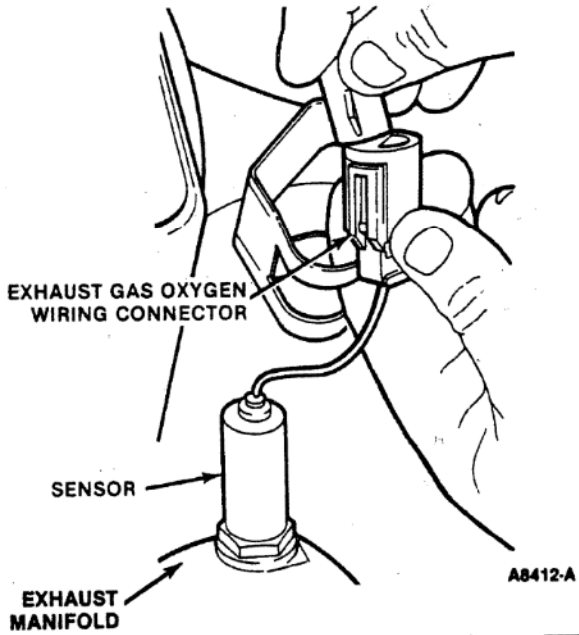
25. Remove the turbocharger air inlet tube.



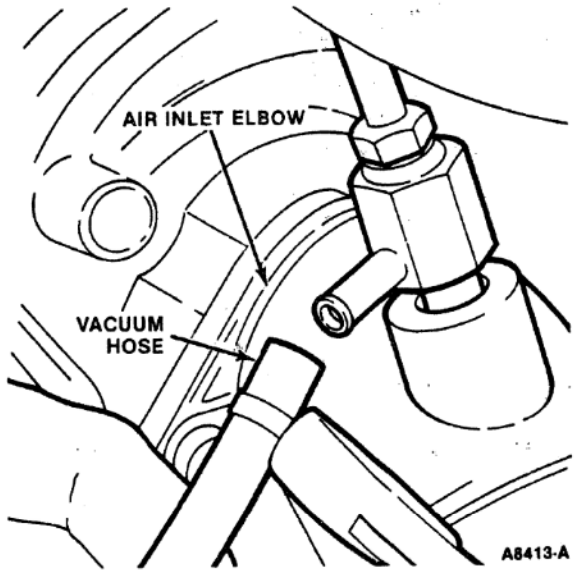
26. Disconnect the orange ground wire at the turbocharger air inlet elbow.



27. Separate the exhaust gas oxygen sensor wiring connector.



28. Disconnect the vacuum hose at the turbocharger air inlet elbow.

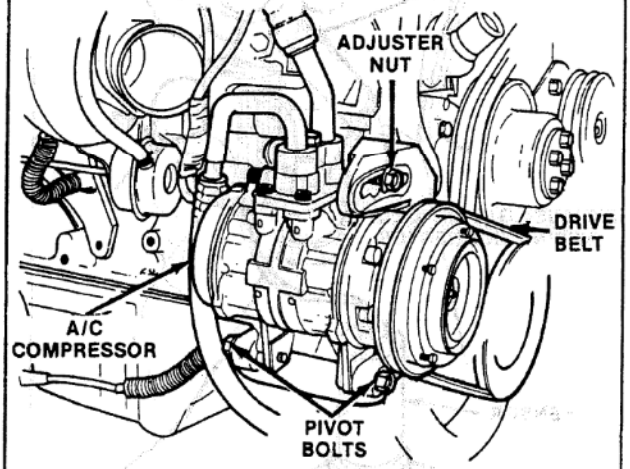


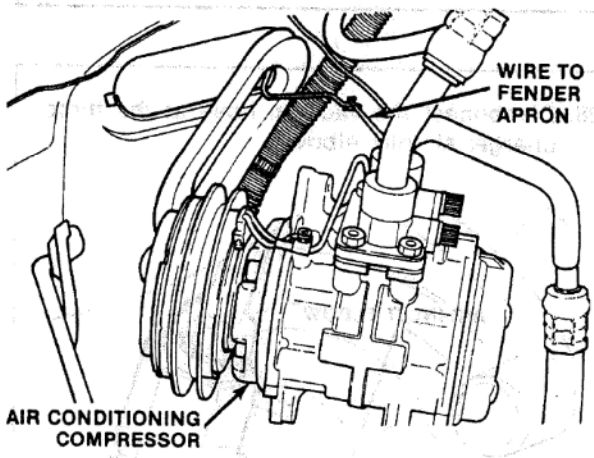
REMOVAL AND INSTALLATION

ENGINE ASSEMBLY

Removal (Continued)

29. Remove the A/C compressor from its mounting bracket and wire aside.

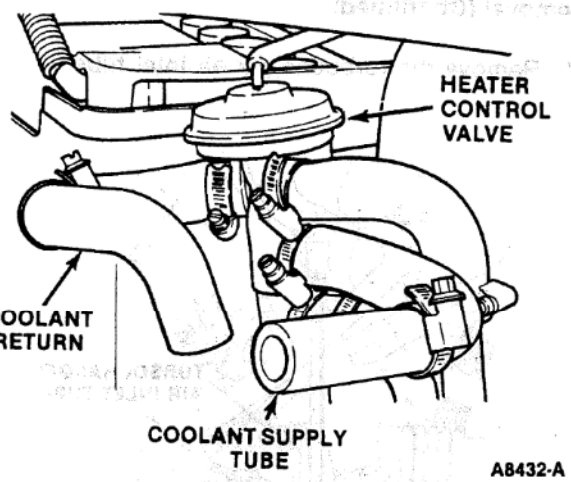




A8430-A

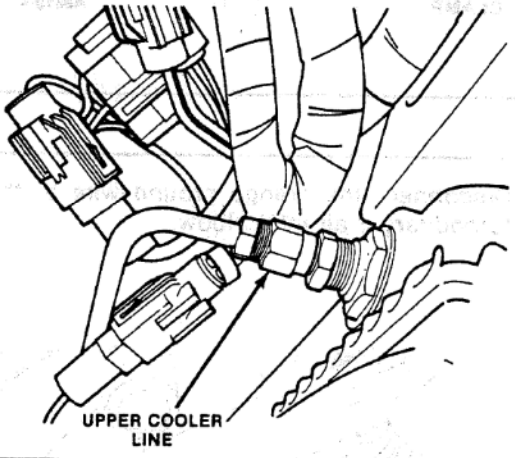
30. On an automatic transmission-equipped vehicle, remove the transmission dipstick tube attaching nut at the turbocharger outlet flange.

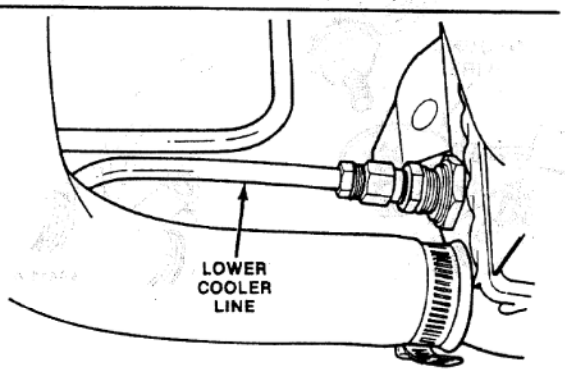
31. Disconnect the coolant supply and return hoses at the heater control valve.



A8432-A

32. On an automatic transmission-equipped vehicle, disconnect the transmission oil cooler lines at the radiator.





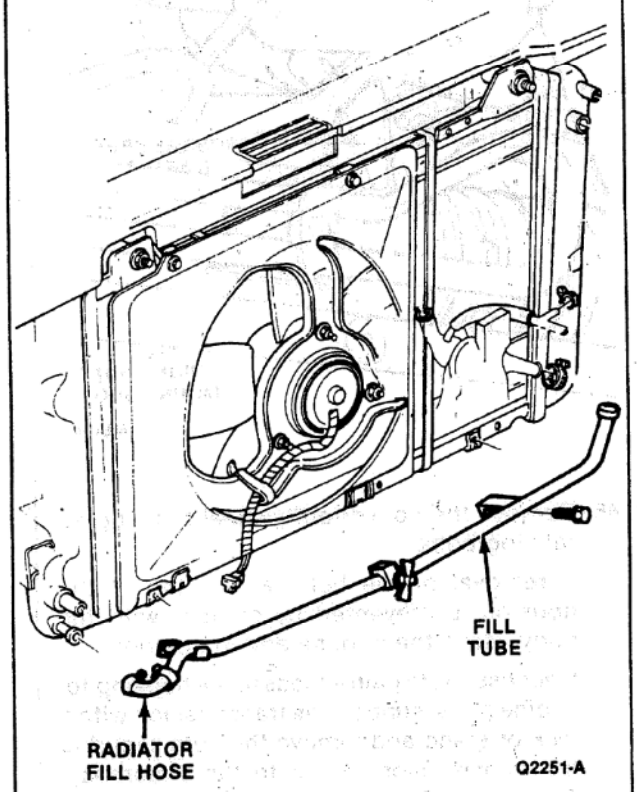
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REMOVAL AND INSTALLATION

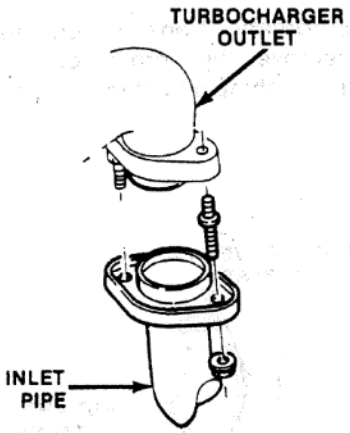
ENGINE ASSEMBLY

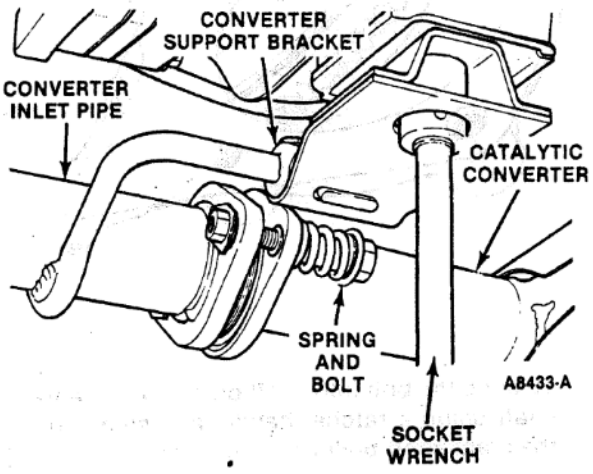
Removal (Continued)

33. Raise the vehicle.
34. Disconnect the radiator refill tube at the refill hose (manual transmission only).



35. Disconnect the radiator lower hose at the radiator.
36. Remove the bolts attaching the radiator to the side rails, and remove the radiator through the bottom of the vehicle.
37. Remove the bolt attaching the chassis ground wire to the A/C compressor bracket.
38. Remove the starter. If necessary, refer to Section 28-02.
39. Remove the nuts attaching the catalytic converter inlet pipe to the turbocharger.





40. Remove the attaching nuts at the catalytic converter-to-converter inlet pipe flange. Remove the catalytic converter support bracket bolt.
41. Remove the inlet pipe.
42. On a manual transmission-equipped vehicle, remove the bolt attaching the engine rear cover to the flywheel housing.

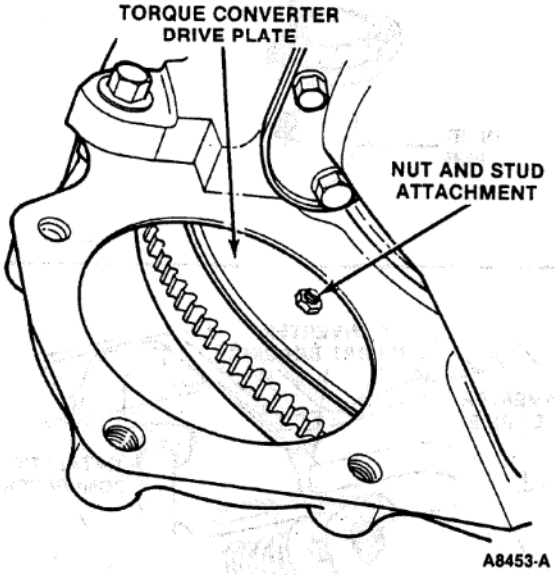
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REMOVAL AND INSTALLATION

ENGINE ASSEMBLY

Removal (Continued)

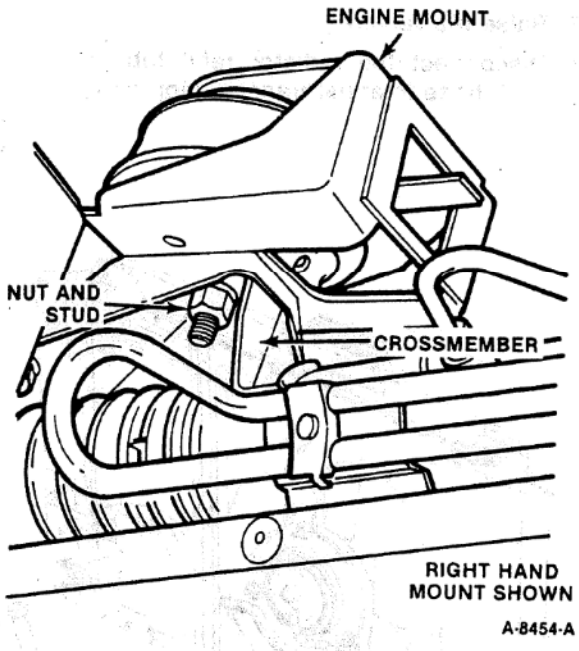
43. On an automatic transmission-equipped vehicle, remove the torque converter-to-drive plate attaching nuts through the starter opening.



To bring the bolt into position, turn the crankshaft using a ratchet handle and socket on the crankshaft pulley attaching bolt.

CAUTION: Always turn the crankshaft clockwise, which is the normal direction of rotation. Backward rotation may cause the timing belt to jump time due to arrangement of the belt tensioner.

44. Remove the stud nuts attaching the engine mounts to the crossmember.



45. Remove the converter/flywheel housing attaching bolts.

    If removal of the bolts at the top of the housing is prevented by contact with the body, leave them loose and in position.

    If necessary, to gain access to the housing-to-engine bolts, support the transmission with a jack or stand and remove the nuts securing the transmission mount to the underbody. Also remove the nuts securing the driveshaft center bearing support to the underbody.

    Lower the transmission and remove the converter/flywheel housing-to-engine bolts. Raise the transmission and secure the transmission mount to the underbody.

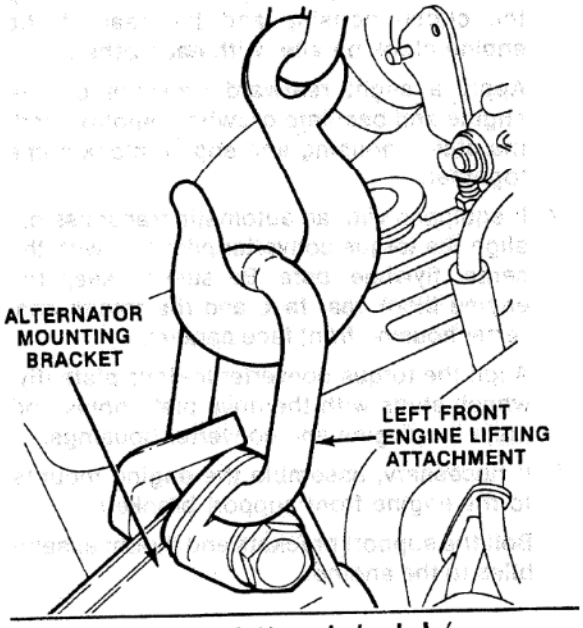
46. Lower the vehicle.

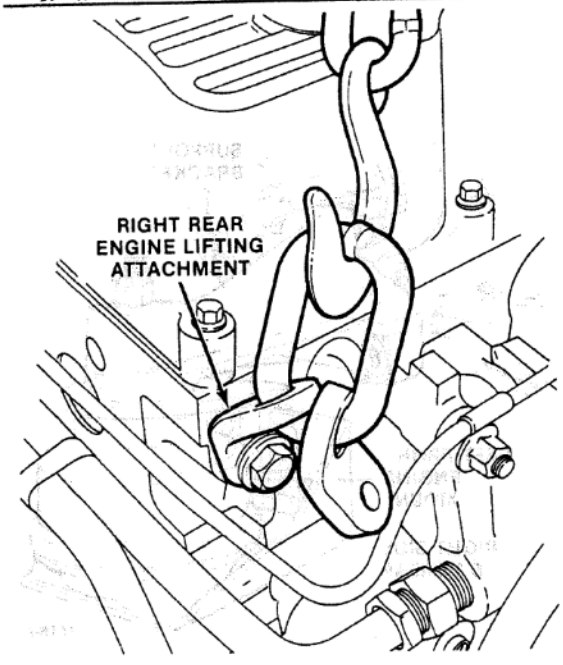
REMOVAL AND INSTALLATION

ENGINE ASSEMBLY

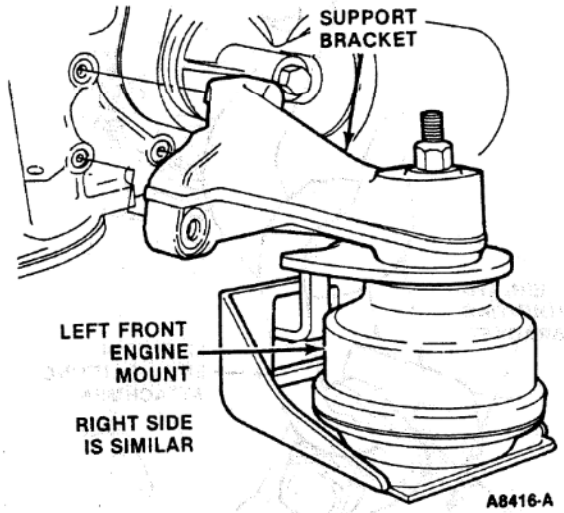
Removal (Continued)

47. Install a suitable engine lifting device.





48. Support the transmission with a floor jack.
49. Raise the engine until the front support lower studs clear the crossmember.
50. Remove the bolts attaching the front support brackets to the engine.



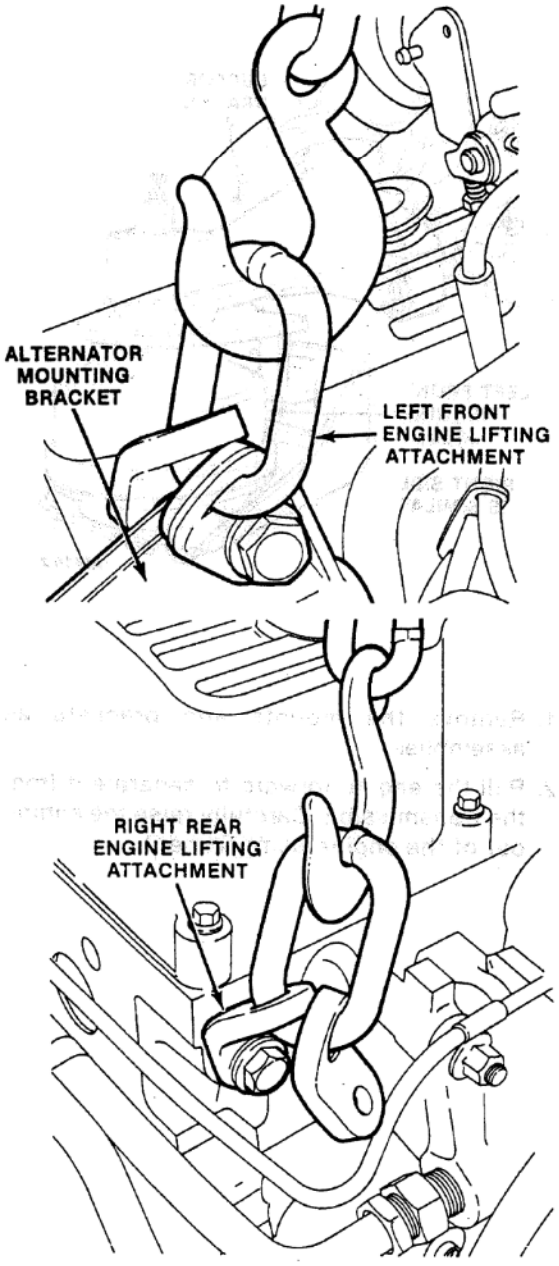
51. Remove the mounts and brackets as assemblies.
52. Pull the engine forward to separate it from the transmission. Carefully raise the engine out of the engine compartment.

REMOVAL AND INSTALLATION

ENGINE ASSEMBLY

Installation

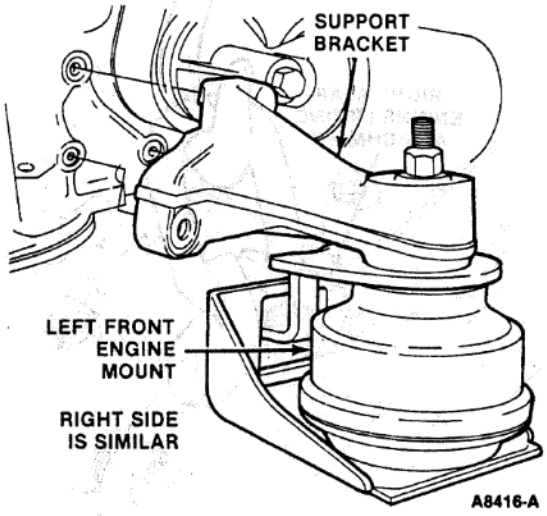
1. Install a suitable engine lifting device.



2. Position the engine over and into the engine compartment. It will probably be necessary to raise and support the transmission.
3. If equipped with a manual transmission, align the transmission input shaft with the clutch friction plate spline while keeping the clutch housing and the rear of the engine block parallel with each other.

   Apply a slight rearward pressure on the engine and oscillate or twist it slightly until the clutch housing and engine block come together.
4. If equipped with an automatic transmission, align the torque converter pilot hub with the center flywheel bore. Be sure to keep the engine block rear face and the torque converter housing front face parallel.

   Align the torque converter-to-drive plate (flywheel) studs with the drive plate holes and mate the engine and converter housings.
5. If necessary, assemble the engine mounts to the engine front support brackets.
6. Bolt the support brackets and mount assemblies to the engine.



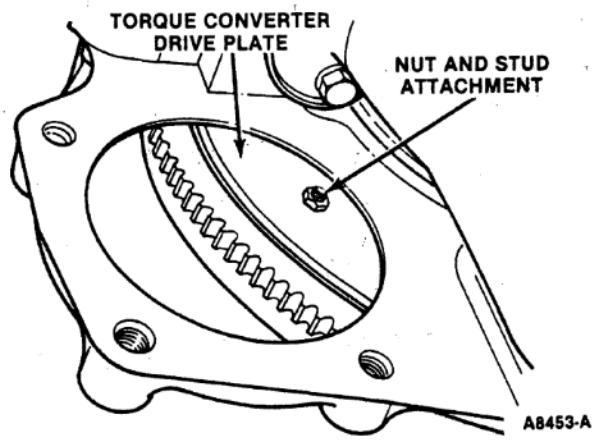
REMOVAL AND INSTALLATION

ENGINE ASSEMBLY

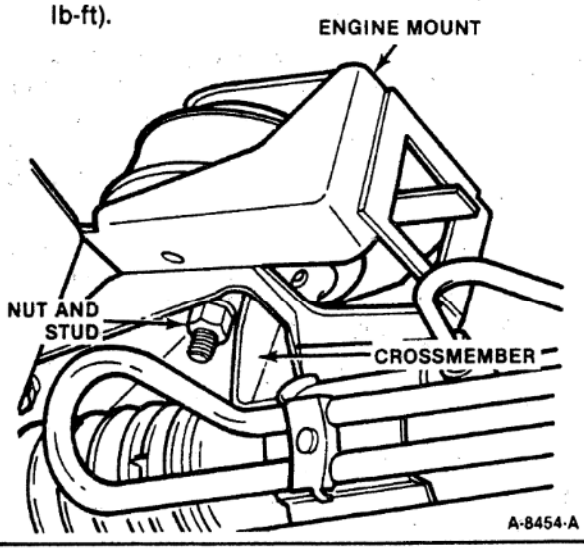
Installation (Continued)

7. Remove the transmission support.
8. Lower the engine until the front engine mount lower studs enter the chassis crossmember.
9. Raise the vehicle.
10. Install the converter or flywheel housing-to-engine lower bolts.
11. If necessary to gain access to the converter or flywheel housing-to-engine upper bolts, support the transmission with a jack or stand. Remove the transmission mount to underbody nuts. If not already off, remove the driveshaft center bearing support nuts.

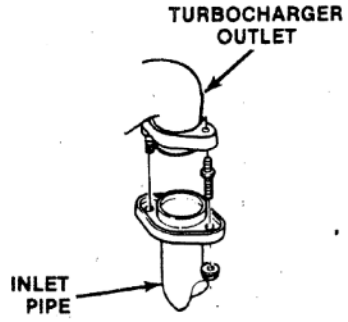
    Lower the transmission until the upper converter or flywheel housing-to-engine bolts can be started. On a manual transmission, torque the clutch housing-to-engine bolts to 70 to 90 N·m (53 to 68 lb-ft). On an automatic transmission, torque the converter housing-to-engine bolts to 30 to 37 N·m (22 to 27 lb-ft).
12. Install and torque the converter-to-drive plate nuts. Torque the nuts to 30 to 40 N·m (26 to 28 lb-ft). To gain access to each stud, turn the engine clockwise (looking at the front of the engine) until the nut can be installed through the engine starter mounting hole.

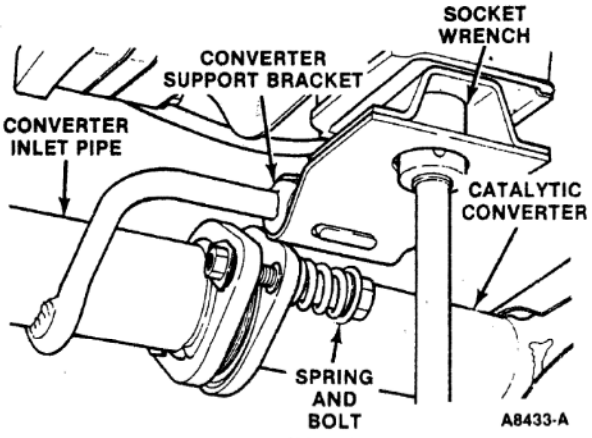


13. Raise the transmission and install the mount to underbody nuts. Torque the nuts to 20 to 25 N·m (15 to 20 lb-ft). Install the driveshaft center bearing support nuts. Torque the nuts to 76 to 82 N·m (55 to 60 lb-ft).
14. Install and torque the engine mount-to-front crossmember nuts to 54 to 64 N·m (38 to 47 lb-ft).



15. Assemble the catalytic converter support bracket onto the converter inlet pipe.





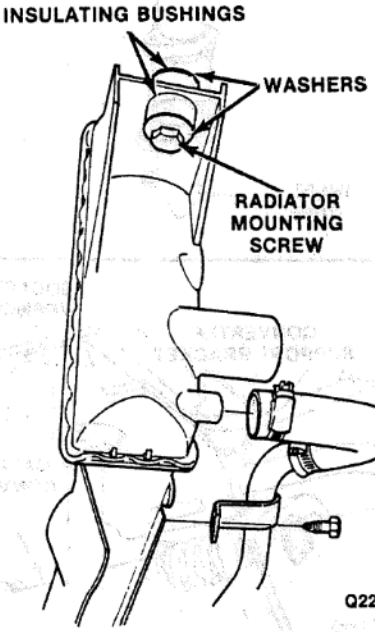
REMOVAL AND INSTALLATION

ENGINE ASSEMBLY

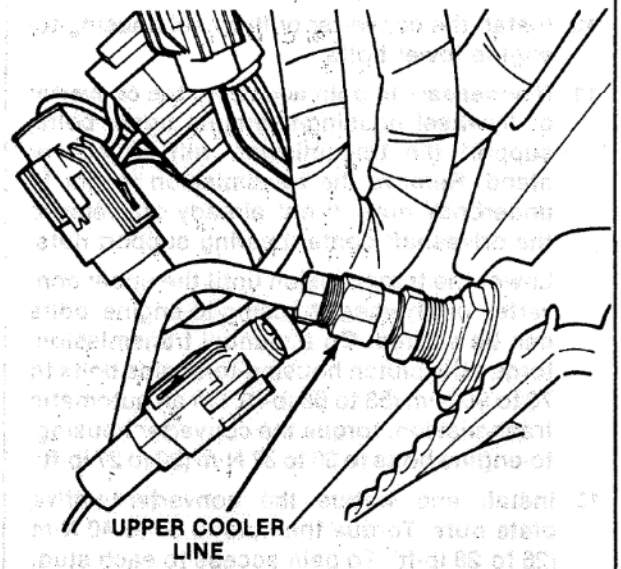
Installation (Continued)

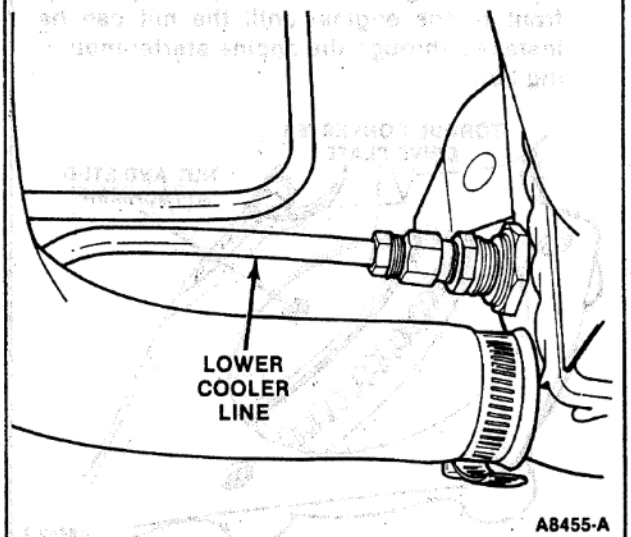
16. Position the inlet pipe and bracket onto the converter and turbocharger. Start the converter-to-inlet pipe bolts, springs and nuts; the turbocharger-to-inlet pipe nuts; and the converter support-to-transmission mount bolt.

    Torque the catalytic converter-to-converter inlet pipe bolts to 35 to 40 N·m (26 to 30 lb-ft). Torque the turbocharger-to-inlet pipe nuts to 35 to 40 N·m (26 to 30 lb-ft). Torque the converter support-to-transmission mount bolt to 50 to 57 N·m (37 to 42 lb-ft).
17. Install the starter and torque the bolts to 8 to 12 N·m (5 to 8 lb-ft).
18. Install and tighten the chassis wire to the A/C compressor bracket.
19. Position the radiator on the chassis side rail mounts. Install and torque the lower mount bolts to 8 to 12 N·m (5 to 8 lb-ft).



20. Connect and tighten the lower radiator hose and the refill tube and hose.
21. Lower the vehicle.
22. On an automatic transmission-equipped vehicle, connect the transmission cooler lines to the radiator.



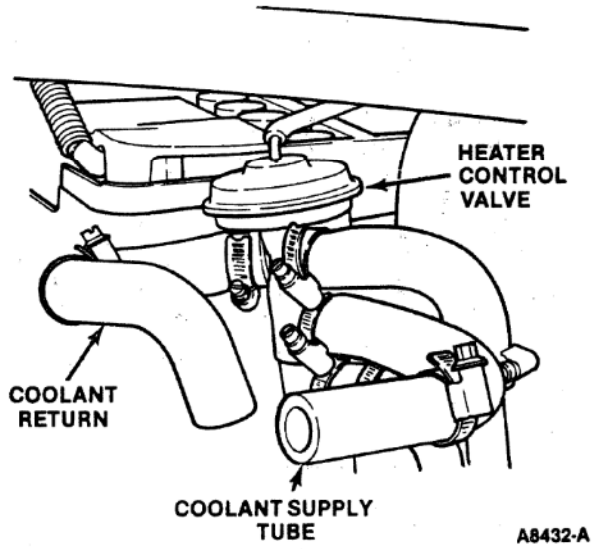


REMOVAL AND INSTALLATION

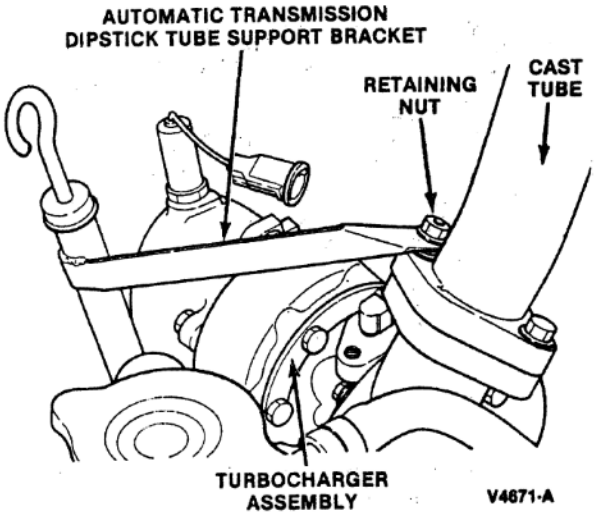
ENGINE ASSEMBLY

Installation (Continued)

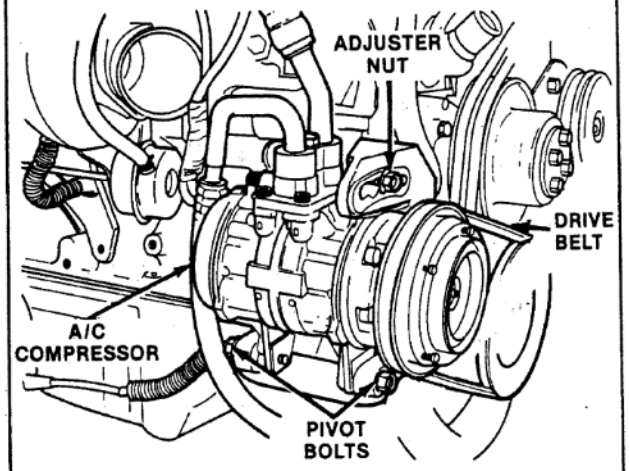
23. Connect the heater supply and return hoses at the heater control valve.



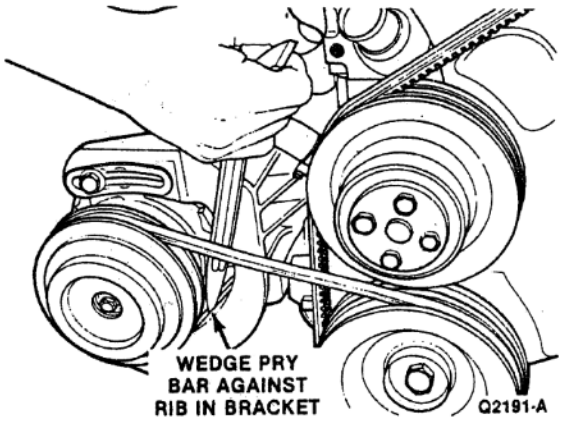
24. Connect the automatic transmission dipstick bracket at the turbocharger-to-turbocharger outlet pipe flange nut.



25. Install the A/C compressor onto the mounting bracket.



Adjust the A/C compressor drive belt. If necessary, refer to Section 27-02.

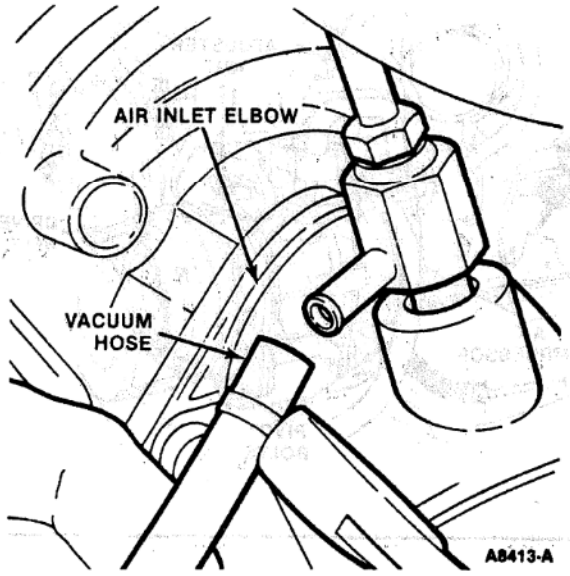


REMOVAL AND INSTALLATION

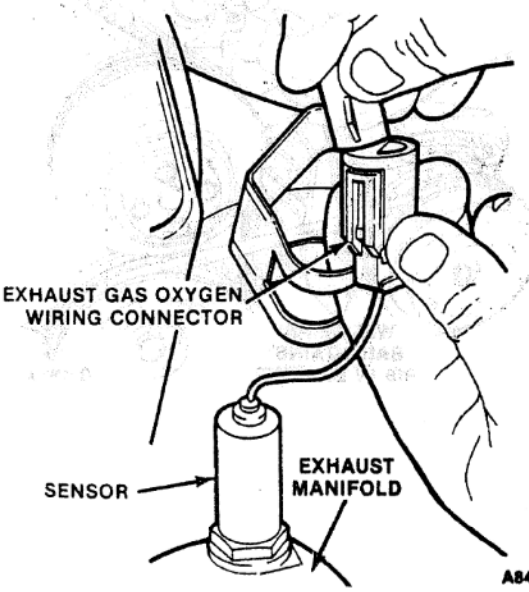
ENGINE ASSEMBLY

Installation (Continued)

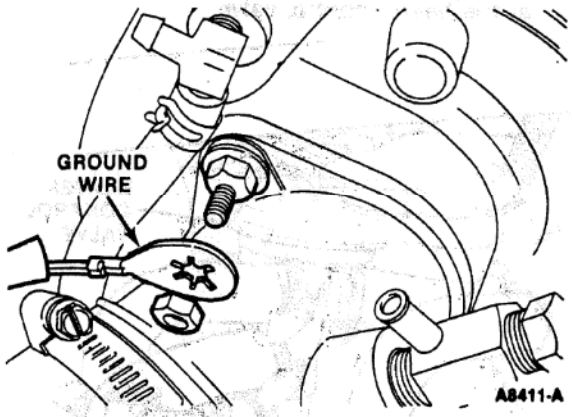
26. Connect the vacuum hose at the turbocharger air inlet elbow.



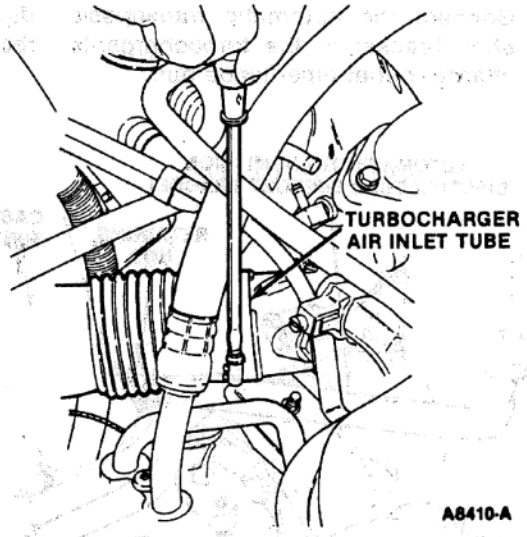
27. Connect the exhaust gas oxygen sensor wiring connector.



28. Attach the orange ground wire at the turbocharger air inlet elbow.



29. Install the turbocharger air inlet tube.



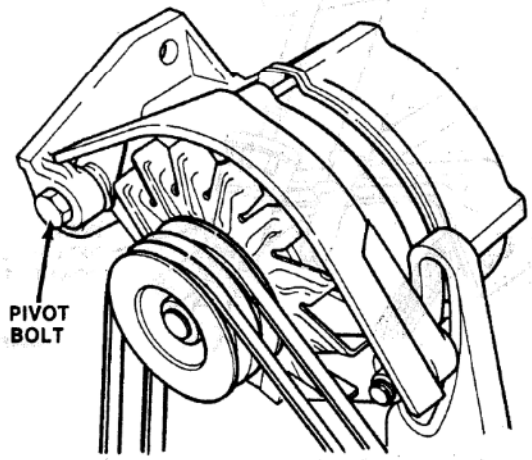
30. Install the power steering pump onto its mounting bracket. If necessary, refer to Section 13-51.

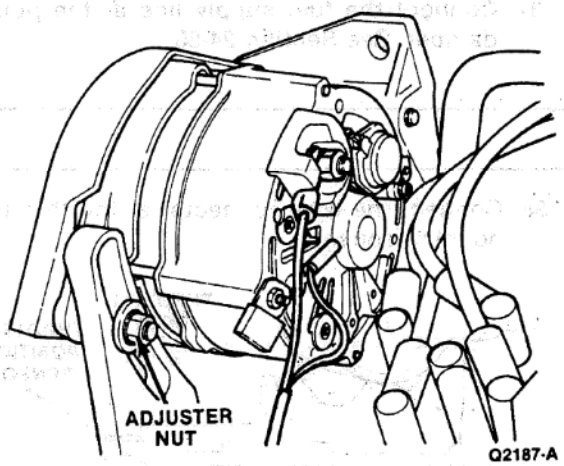
REMOVAL AND INSTALLATION

ENGINE ASSEMBLY

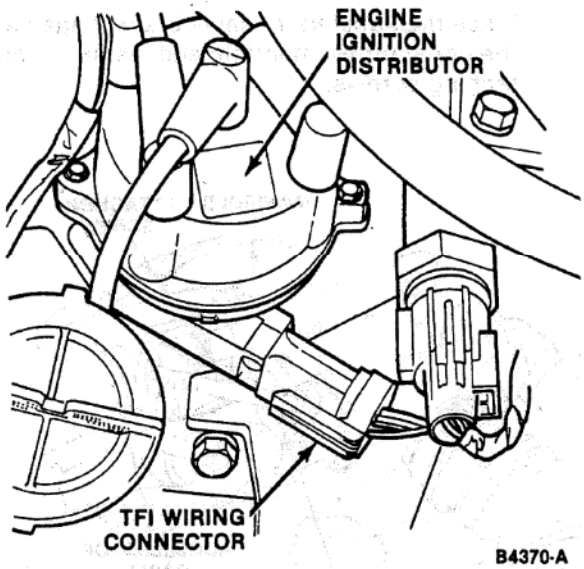
Installation (Continued)

31. Install the alternator onto its mounting bracket.

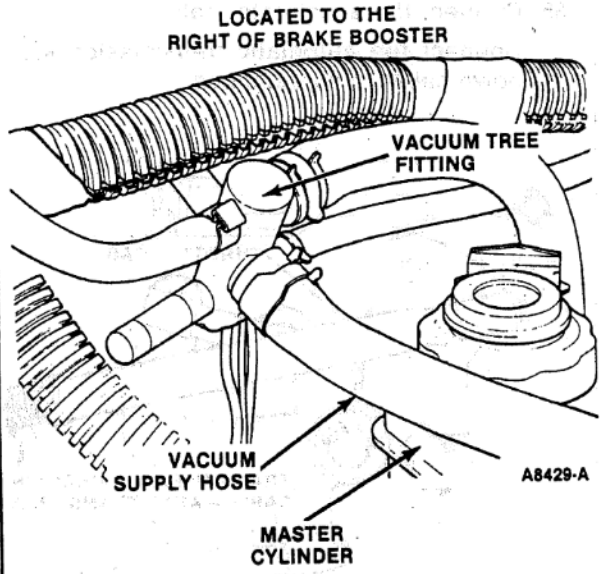




32. Connect the wiring to the distributor TFI module.



33. Connect the vacuum supply hose to the tree on the engine side of the dash panel.

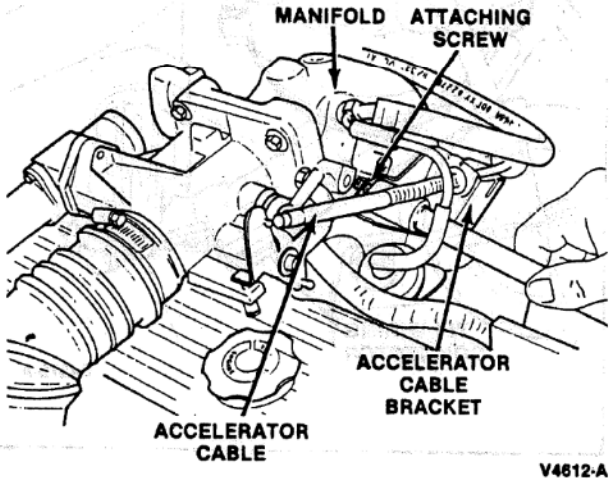


REMOVAL AND INSTALLATION

ENGINE ASSEMBLY

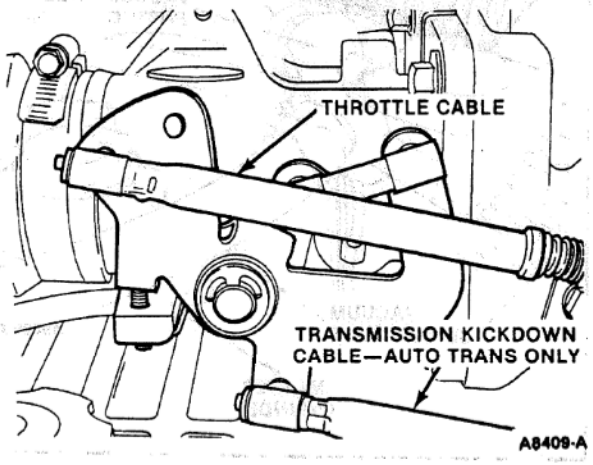
Installation (Continued)

34. Place the accelerator cable bracket against the upper intake manifold and install the attaching screws.

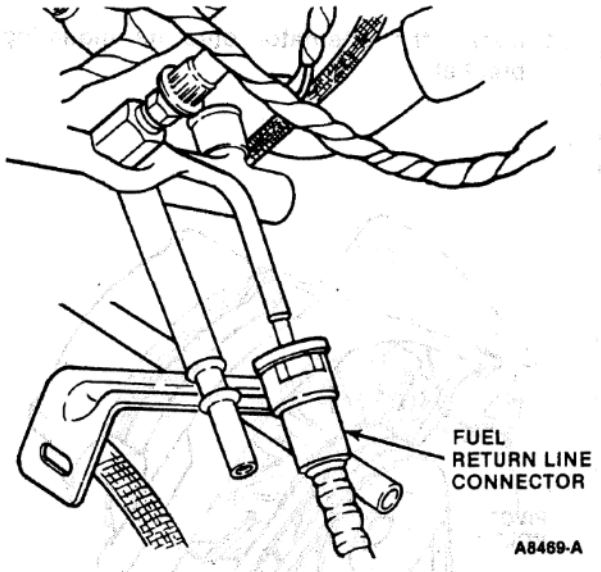


35. Connect the accelerator cable.

    Connect the automatic transmission kickdown cable, if so equipped.

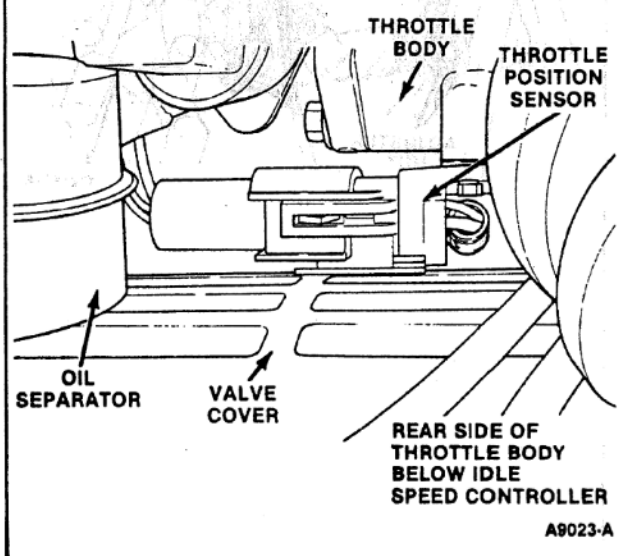


36. Connect the fuel return line.



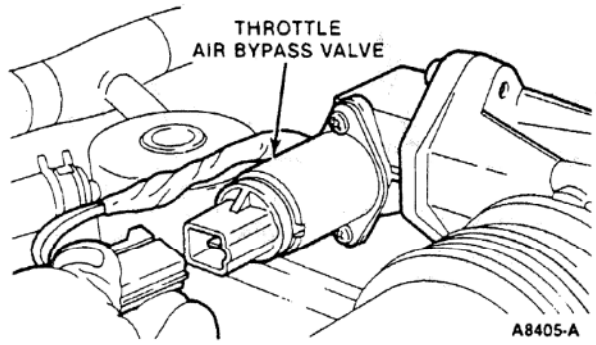
37. Connect the fuel supply line at the pulse damper. See Section 24-50.

38. Connect the wire connector at the throttle position sensor.

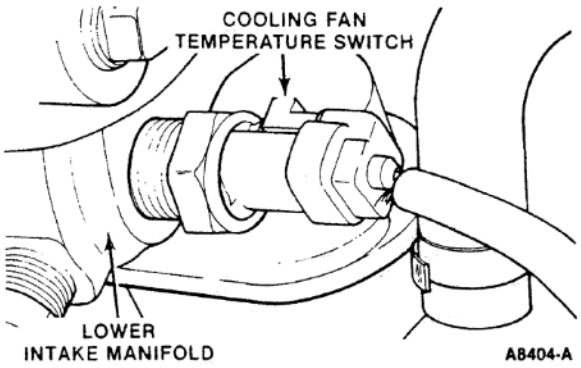


REMOVAL AND INSTALLATION (Continued)

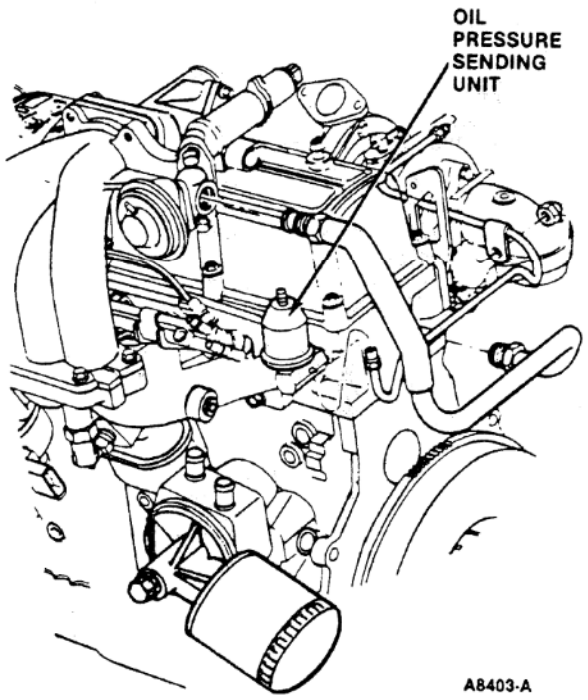
39. Connect the wire connector at the throttle air bypass valve.



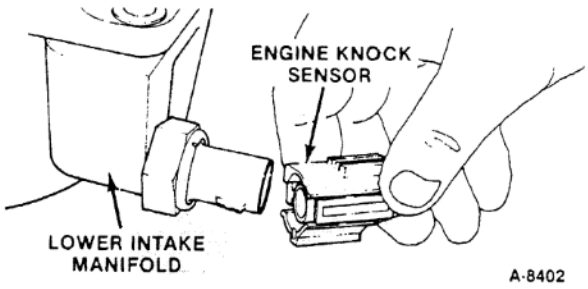
40. Connect the wire connector at the cooling fan temperature switch.



41. Connect the wire at the oil pressure sending unit.

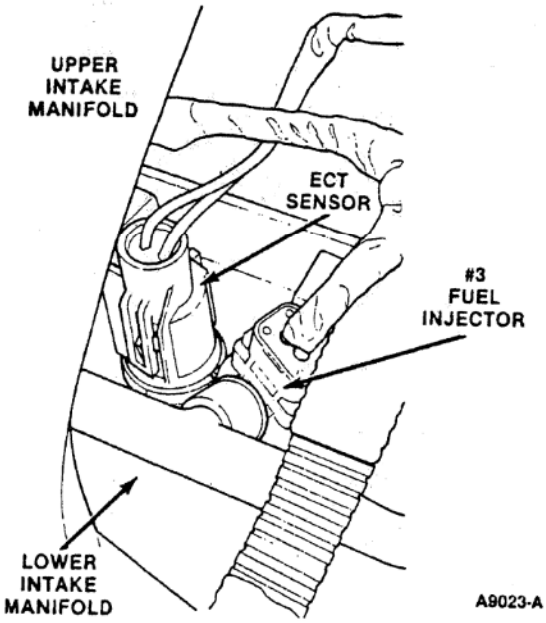


42. Connect the wire at the engine knock sensor.

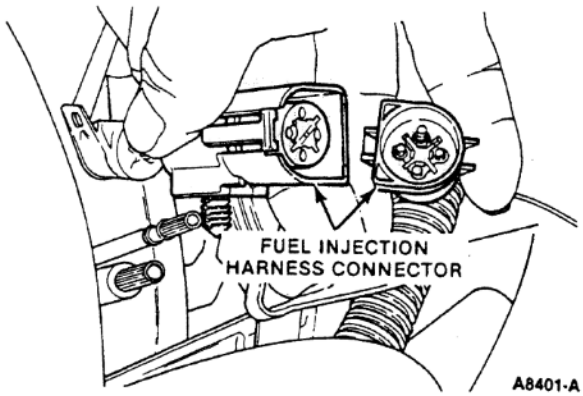


REMOVAL AND INSTALLATION (Continued)

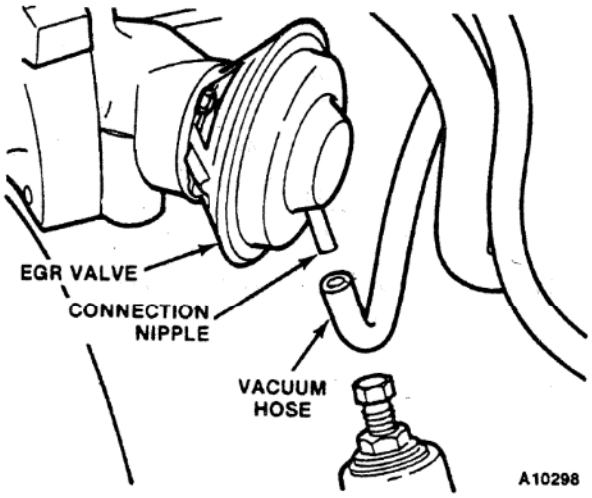
43. Connect the wire at the EEC IV engine coolant temperature sensor.



44. Connect the fuel injection wiring harness connector.

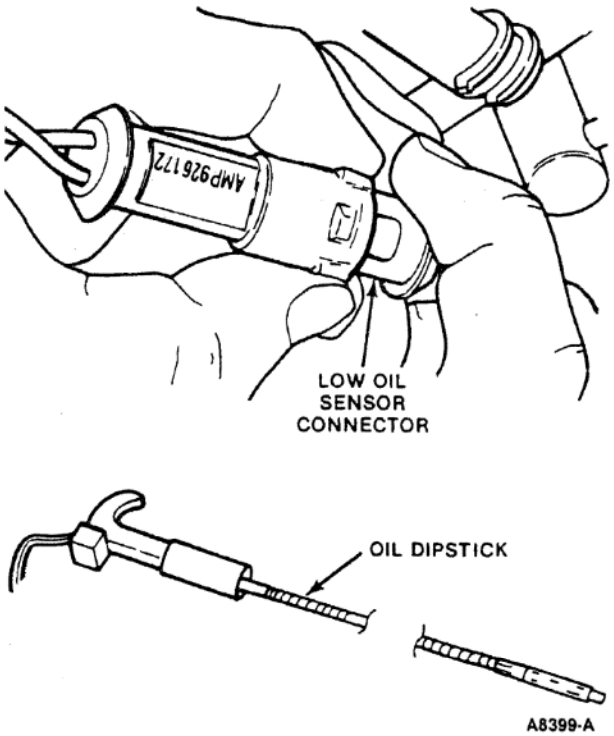


45. Attach the vacuum hose to the EGR valve.



46. Connect the wire connector at the oil level sensor and install the engine oil level dipstick.

NOTE: Electrical connector at oil dipstick applies to all units built prior to 3-9-87.

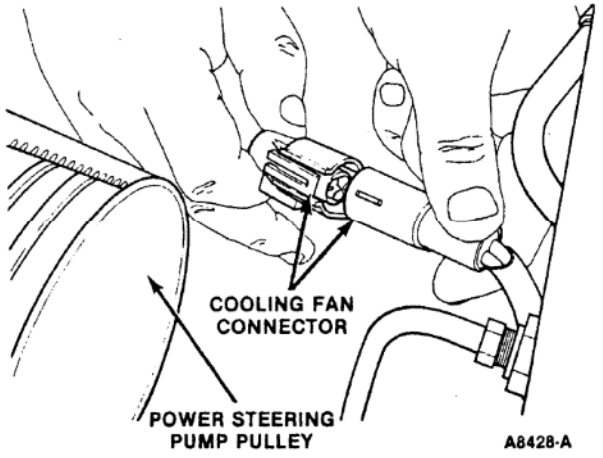


REMOVAL AND INSTALLATION

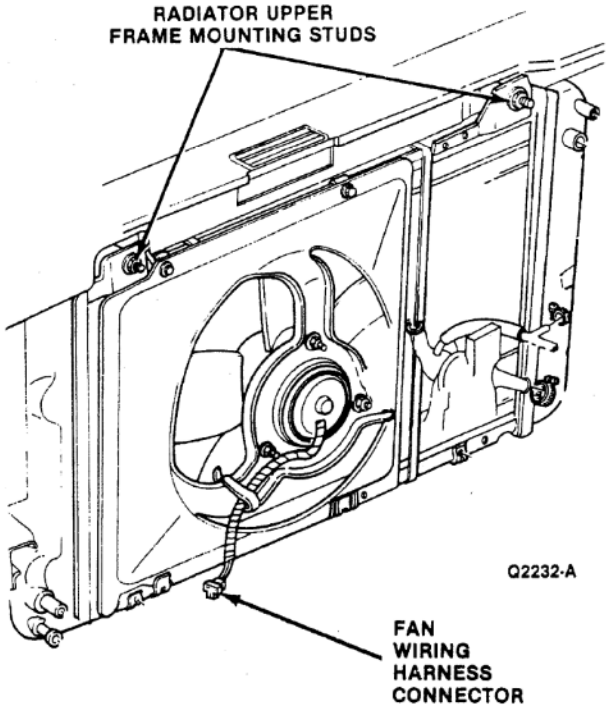
ENGINE ASSEMBLY

Installation (Continued)

47. Connect the wiring at the cooling fan.

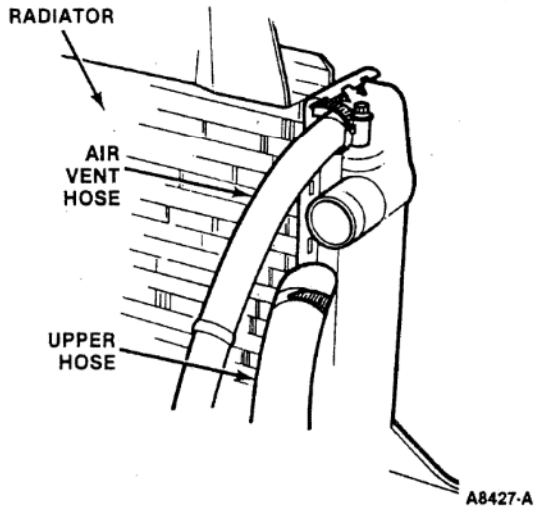


48. Install and torque the upper radiator attaching bolts to 20 to 25 N·m (15 to 18 lb-ft).



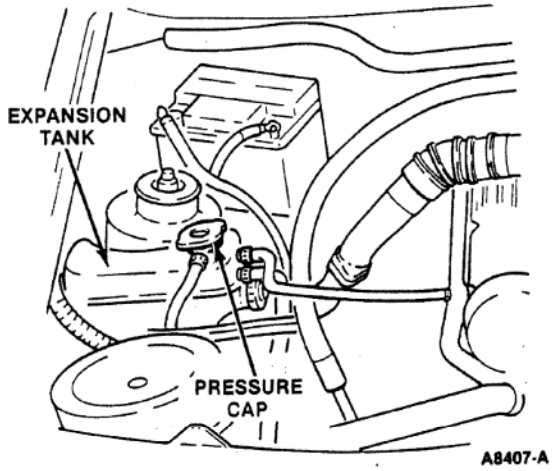
49. Connect the radiator air vent hose at the radiator (manual transmission only).

50. Connect the radiator upper hose at the radiator.



51. Close the radiator drain valve.

Fill the cooling system and install the cap on the coolant expansion tank.



CHECKS AND ADJUSTMENTS

BASE PROCEDURE 1
VALVE CLEARANCE CHECK

First complete:

- Base Procedure 9—Disassembly, Rocker Arm Cover Removal

Then, proceed with the following:

SPECIAL SERVICE TOOL REQUIRED:

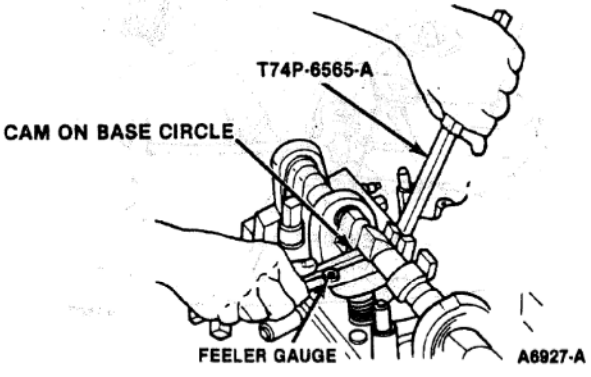
T74P-6565-A Valve Spring Compressor

1. Position the camshaft so that the base circle of the lobe is facing the cam follower of the valve to be checked.

   To position the camshaft lobes, turn the crankshaft, using a ratchet handle and socket on the crankshaft pulley attaching bolt.

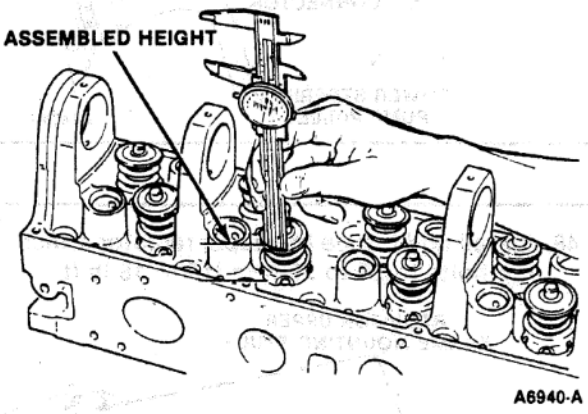
CAUTION: Always turn the crankshaft clockwise, which is the normal direction of rotation. Reverse rotation may cause the timing belt to jump time due to the arrangement of the belt tensioner.

2. Using Valve Spring Compressor T74P-6565-A, or equivalent, slowly apply pressure on the lash adjuster side of the cam follower until the lash adjuster is completely collapsed. Hold the follower in this position and measure the clearance between the base circle of the cam and the follower using a feeler gauge. The clearance should be 0.09 to 0.14 mm (0.0035 to 0.0055 in.).



- If the clearance is excessive, remove the cam follower and inspect for damage.

- If the cam follower appears to be intact, and not excessively worn, measure the valve spring assembled height to be sure the valve is not sticking.



- If the valve spring assembled height is correct, check the dimensions of the camshaft.

- If the camshaft dimensions are to specification, remove, clean and test the lash adjuster.

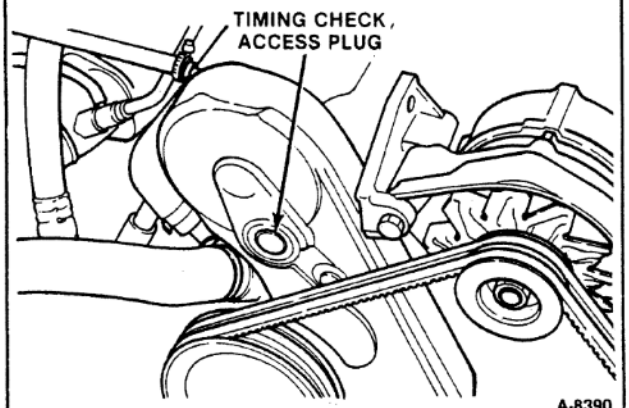
NOTE: For any or all of the above checks, refer to the appropriate component overhaul or inspection procedure in this section.

CHECKS AND ADJUSTMENTS

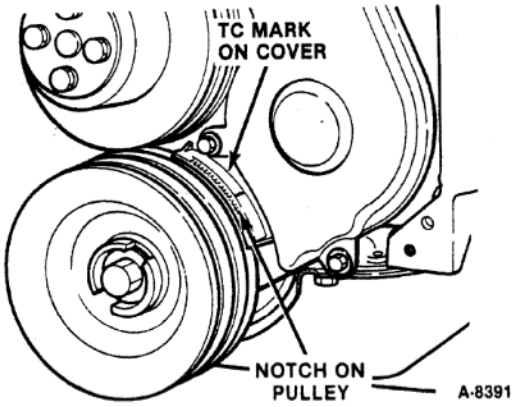
BASE PROCEDURE 2
CAMSHAFT TIMING CHECK

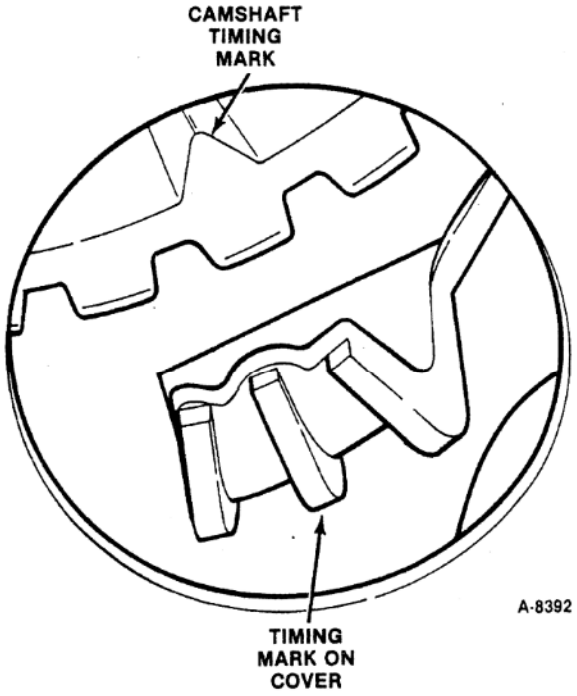
An access plug is provided in the cam drive belt cover so that camshaft timing can be checked without removal of the cover or any other parts.

1. Remove the access plug from the cam drive belt cover.



2. Set the crankshaft to TDC by aligning the TC mark on the belt cover with the notch on the crankshaft pulley.





To align the timing marks, turn the crankshaft pulley attaching bolt.

CAUTION: Always turn the crankshaft clockwise, which is the normal direction of rotation. Reverse rotation may cause the timing belt to jump time due to the arrangement of the belt tensioner.

3. Look through the access hole in the belt cover to be sure that the timing mark on the cam drive sprocket is lined up with the pointer on the inner belt cover.

   If the mark is not in sight, turn the crankshaft one complete revolution and check the timing mark alignment.

   - If the timing marks are aligned, the camshaft is properly timed to the crankshaft.
   - If the timing marks do not align, proceed to Base Procedure 3, Camshaft Timing Adjustment, in this section.

CHECKS AND ADJUSTMENTS

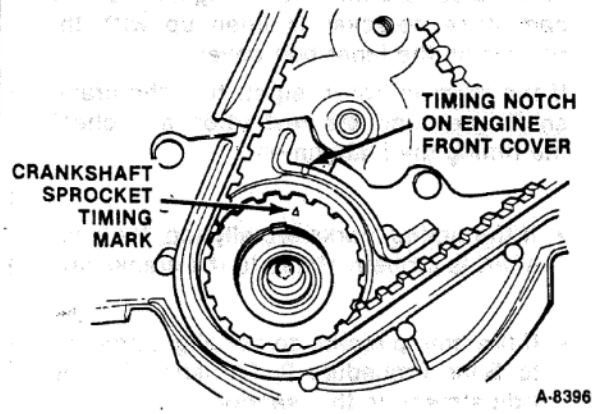
BASE PROCEDURE 3
CAMSHAFT TIMING ADJUSTMENT

First complete:

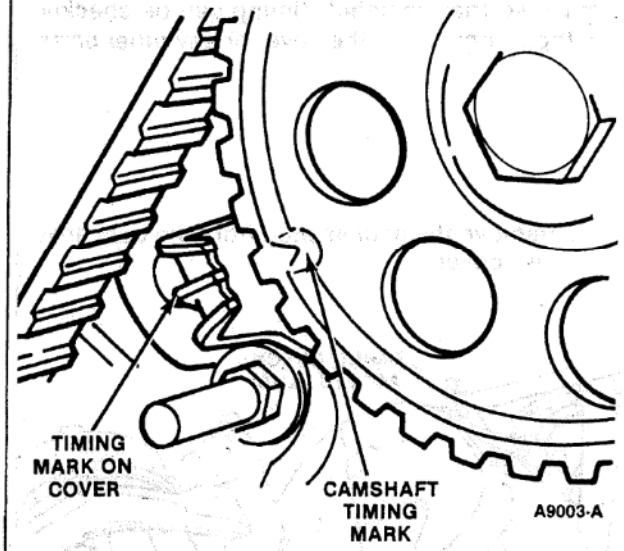
- Base Procedure 5—Disassembly, Drive Belts Removal
- Base Procedure 6—Disassembly, Water Pump Pulley Removal
- Base Procedure 7—Disassembly, Timing Belt Cover Removal
- Base Procedure 12—Disassembly, Timing Belt Removal
- Base Procedure 14—Diasasembly, Crankshaft Damper and Pulley Removal

Then, proceed with the following:

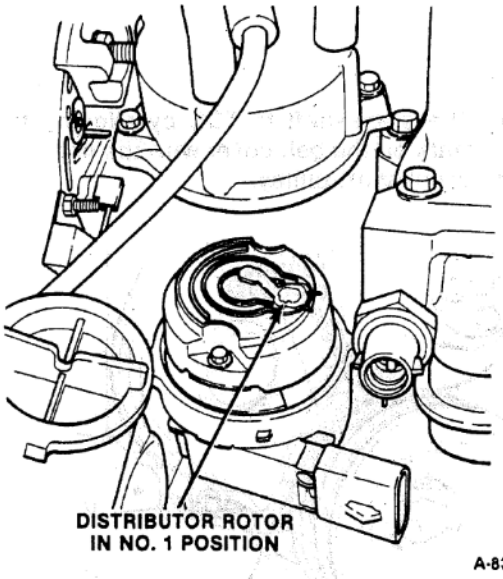
1. Remove the spark plugs. If necessary, refer to Section 23-02.
2. Turn the crankshaft to align the timing mark on the crankshaft sprocket with the timing mark on the engine front cover.



3. Turn the camshaft to align the timing mark on the camshaft sprocket with the timing mark on the inner timing belt cover.



4. Remove the distributor cap and set the rotor to the number one firing position by turning the auxiliary shaft.

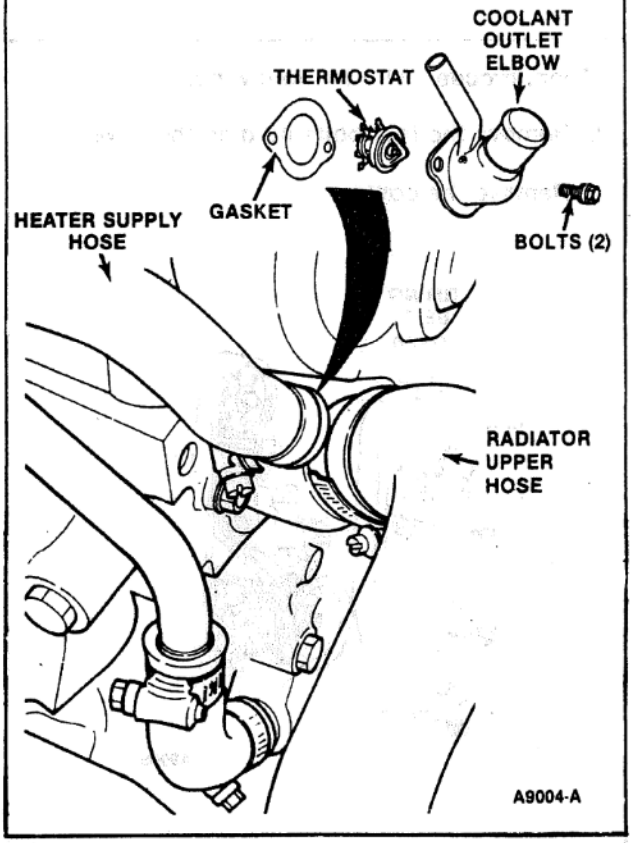


To install the timing belt, refer to Base Procedure 12—Assembly.

ENGINE COMPONENT DISASSEMBLY

BASE PROCEDURE 4—DISASSEMBLY COOLANT OUTLET ELBOW OR THERMOSTAT REMOVAL

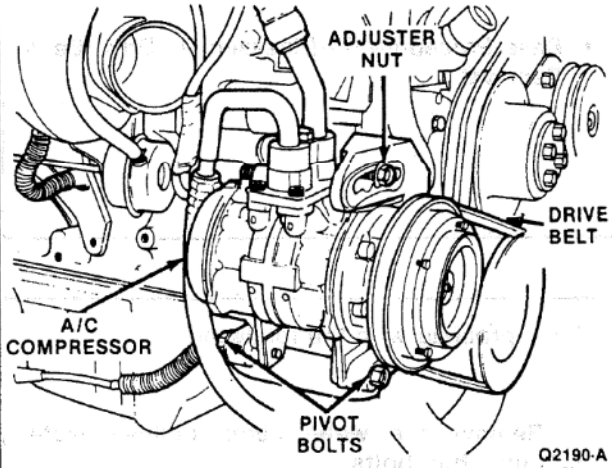
1. Loosen the cap on the coolant expansion tank. Drain the coolant from the radiator. If necessary, refer to Section 27-03 for drain location.
2. Loosen the clamps and remove the upper radiator hose and the heater supply hose at the coolant outlet.
3. Remove two bolts attaching the coolant outlet elbow to the cylinder head.
4. Remove the coolant outlet and the thermostat.



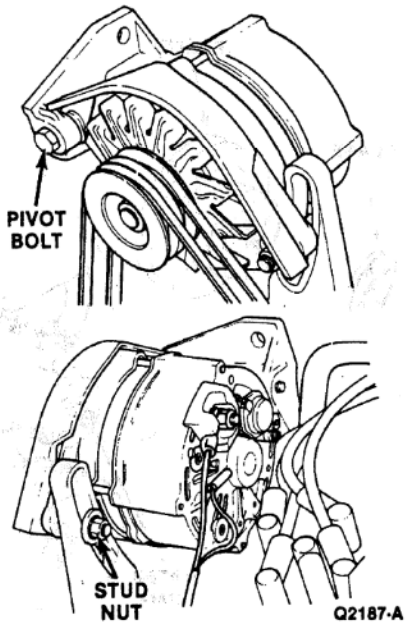
To install the coolant outlet elbow and thermostat, refer to Base Procedure 4—Assembly.

BASE PROCEDURE 5—DISASSEMBLY DRIVE BELTS REMOVAL

1. Loosen the A/C compressor drive belt adjusting bolts. Rotate the compressor toward the engine and remove the belt.



2. Loosen the alternator pivot bolt and adjuster nut. Rotate the alternator downward and remove the drive belts.



To install the drive belts, refer to Base Procedure 5—Assembly.

ENGINE COMPONENT DISASSEMBLY

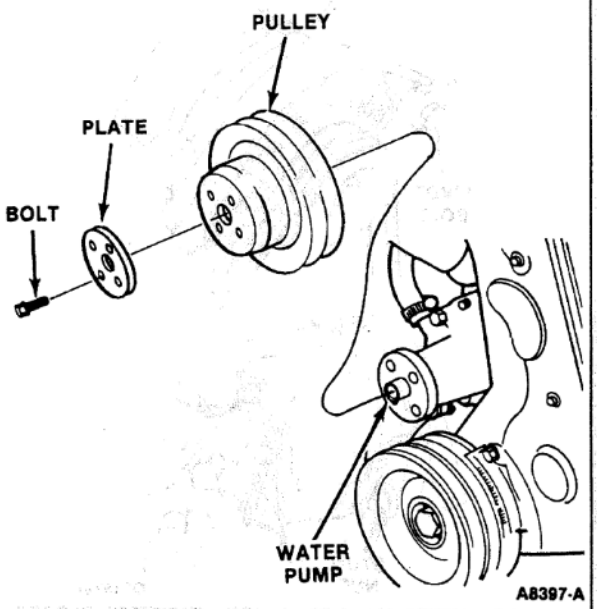
BASE PROCEDURE 6—DISASSEMBLY
WATER PUMP PULLEY REMOVAL

First complete:

- Base Procedure 5—Disassembly Drive Belts Removal

Then, proceed with the following:

1. Remove the water pump pulley-to-water pump hub bolts.
2. Remove the pulley.



To install the water pump pulley, refer to Base Procedure 6—Assembly.

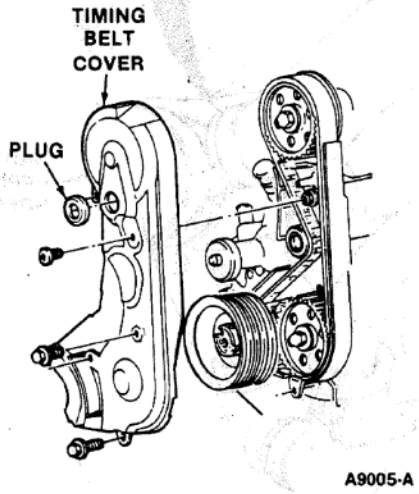
BASE PROCEDURE 7—DISASSEMBLY
TIMING BELT COVER REMOVAL

First complete:

- Base Procedure 5—Disassembly, Drive Belts Removal
- Base Procedure 6—Disassembly, Water Pump Pulley Removal

Then, proceed with the following:

1. Remove the four bolts holding the cover.
2. Remove the cover.



To install the timing belt cover, refer to Base Procedure 7—Assembly.

ENGINE COMPONENT DISASSEMBLY (Continued)

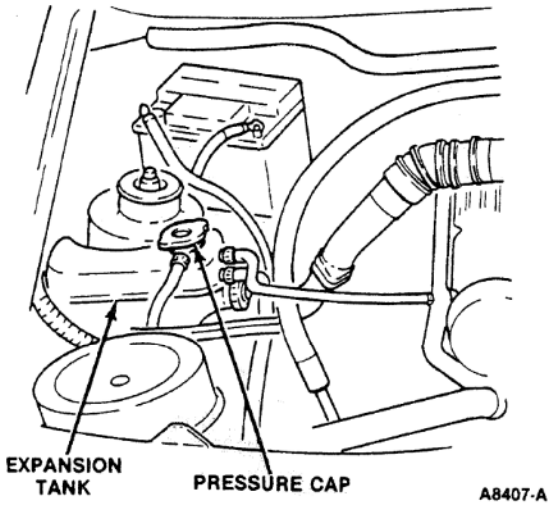
Base Procedure 8—Disassembly Water Pump Removal

First complete:

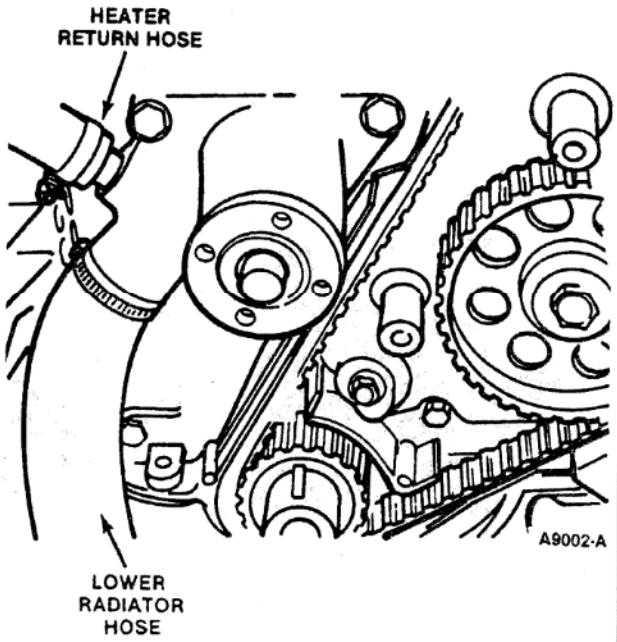
- Base Procedure 5—Disassembly, Drive Belts Removal
- Base Procedure 6—Disassembly, Water Pump Pulley Removal
- Base Procedure 7—Disassembly, Timing Belt Cover Removal

Then, proceed with the following:

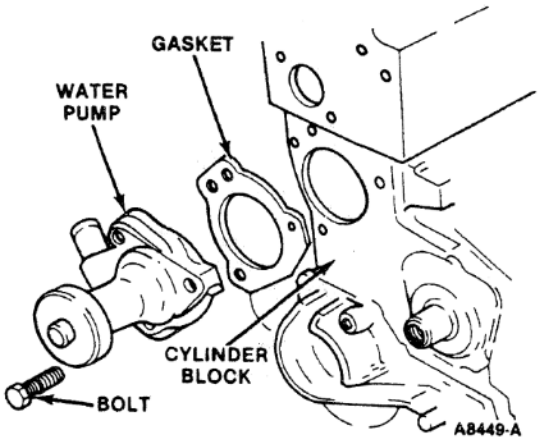
1. Loosen the cap on the coolant expansion tank. Drain the coolant from the radiator. If necessary, refer to Section 27-03 for the radiator drain location.



2. Remove the radiator lower hose and the heater return hose from the water pump.



3. Remove the water pump bolts and the water pump.

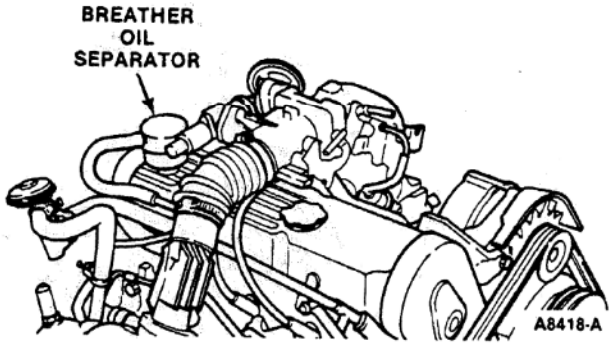


To install the water pump, refer to Base Procedure 8—Assembly.

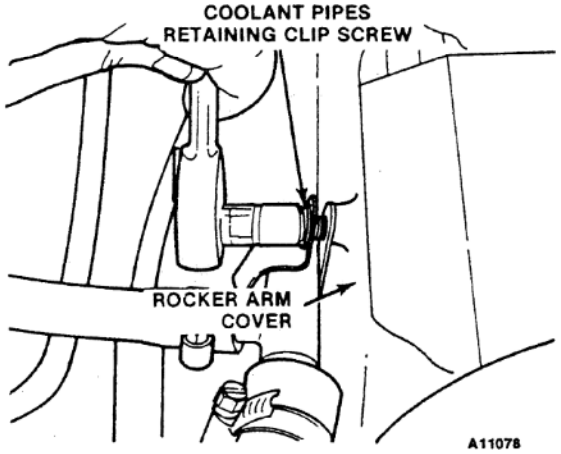
ENGINE COMPONENT DISASSEMBLY (Continued)

Base Procedure 9—Disassembly Rocker Arm Cover/Gasket Removal

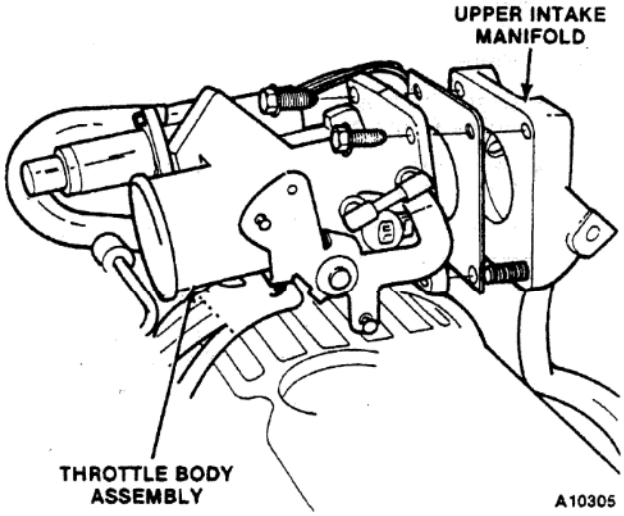
1. Loosen the clamp on the PCV hose at the oil separator on the rocker arm cover and disconnect the hose.
2. Disconnect the coolant hose that passes over the rear of the rocker arm cover.



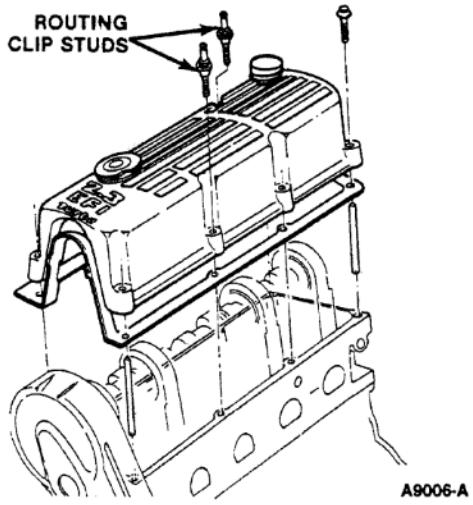
3. Remove the coolant pipes retaining clip screw from the right-front side of the rocker arm cover.



4. Remove the throttle body. Refer to Section 24-29.



5. Disconnect the spark plug wires at the spark plugs and at the rocker arm cover studs. Fold them toward the distributor.
6. Remove the rocker arm cover retaining screws and studs.
7. Remove the rocker arm cover and gasket.



To install the rocker arm cover, refer to Base Procedure 9—Assembly.

ENGINE COMPONENT DISASSEMBLY

BASE PROCEDURE 10—DISASSEMBLY HYDRAULIC LASH ADJUSTER REMOVAL

First complete:

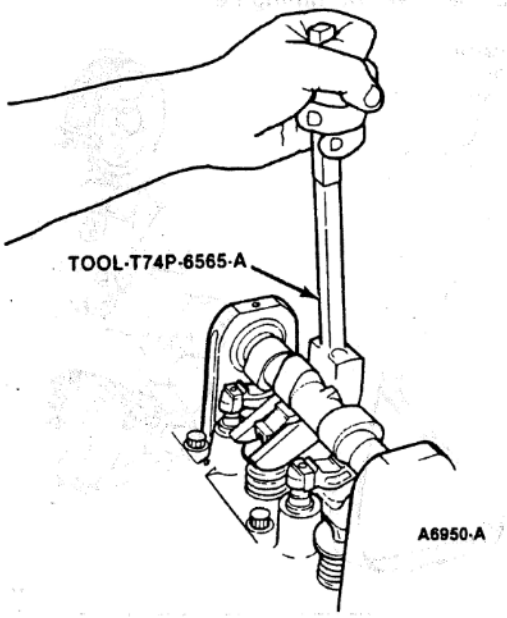
- Base Procedure 9—Disassembly, Rocker Arm Cover Removal

Then, proceed with the following:

SPECIAL SERVICE TOOL REQUIRED:

Valve Spring Compressor T74P-6565-A

1. Rotate the engine in its normal direction of rotation until the base circle of the camshaft lobe, of the selected valve, is contacting the cam follower.
2. Using Valve Spring Compressor Tool T74P-6565-A, or equivalent, compress the valve spring until the cam follower can be removed out and over the hydraulic lash adjuster.
3. Lift out the hydraulic lash adjuster.
4. Repeat steps 1 through 3 as required for remaining lash adjusters.



To install the hydraulic lash adjusters, refer to Base Procedure 10—Assembly.

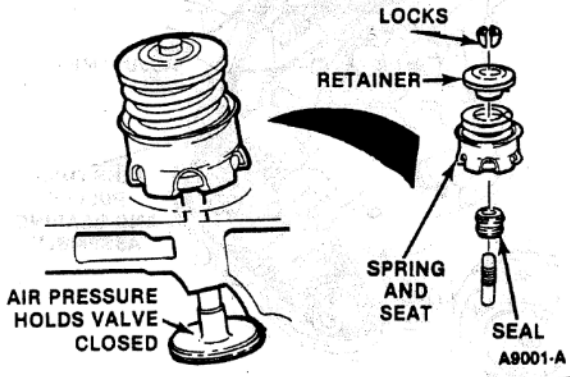
BASE PROCEDURE 11—DISASSEMBLY VALVE SPRINGS AND SEALS REMOVAL

First complete:

- Base Procedure 9—Disassembly Rocker Arm Cover Removal

Then, proceed with the following:

1. Rotate the engine in its normal direction of rotation until the base circle of the camshaft lobe, of the selected valve, is contacting the cam follower. Be sure the other valve of that cylinder is also closed.
2. Using Valve Spring Compressor Tool T74P-6565-A, or equivalent, compress the valve spring until the cam follower can be removed out and over the hydraulic lash adjuster.
3. Install a compressed air adapter in the spark plug hole with at least 140 psi of air pressure available. Turn on the air pressure to hold that cylinder's valves against their seats.
   - Both valves must be closed to hold air pressure.
4. Depress the valve spring using Spring Compressor Tool T74P-6565-A, or equivalent. Remove the locks, spring retainer, spring and seal.
5. Fasten a rubberband or string to the valve key groove to prevent losing a valve if a valve is opened or the air pressure drops.



To install the valve springs and seals, refer to Base Procedure 11—Assembly.

ENGINE COMPONENT DISASSEMBLY

BASE PROCEDURE 12—DISASSEMBLY TIMING BELT REMOVAL

First complete:

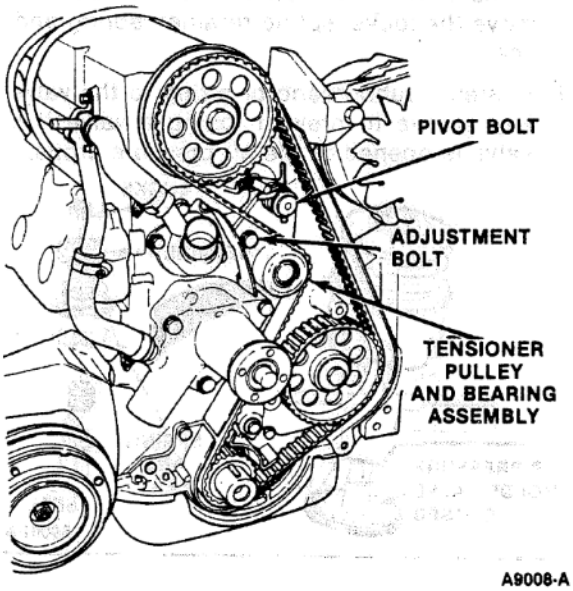
- Base Procedure 5—Disassembly, Drive Belts Removal
- Base Procedure 6—Disassembly, Water Pump Pulley Removal
- Base Procedure 7—Disassembly, Timing Belt Cover Removal
- Base Procedure 14—Disassembly, Crankshaft Damper and Pulley Removal

Then, proceed with the following:

SPECIAL SERVICE TOOL REQUIRED:

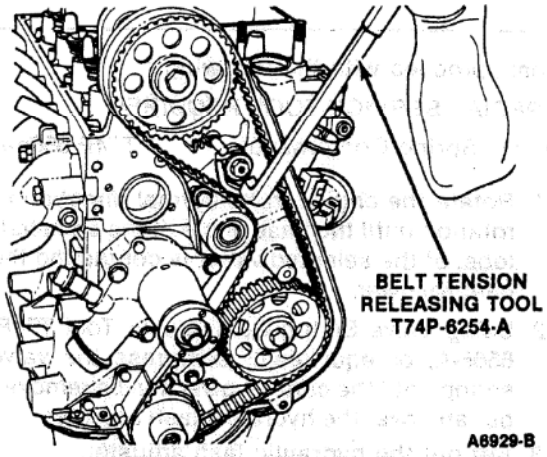
Camshaft Belt Tensioner Tool T74P-6254-A

1. Loosen the timing belt tensioner adjustment bolt.

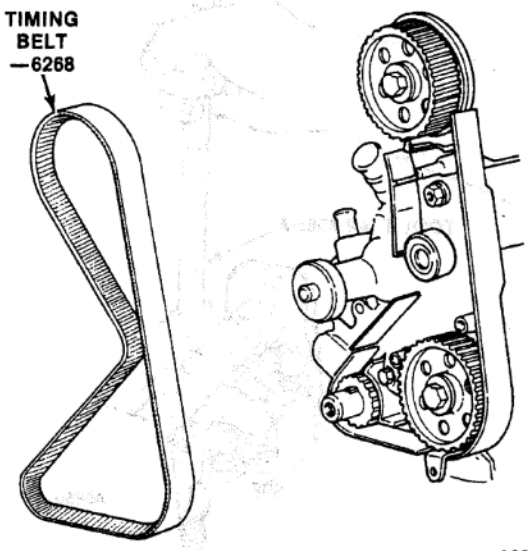


2. Using Camshaft Belt Tensioner Tool T74P-6254-A, pry the tensioner away from the timing belt.

   While holding the tensioner away from the belt, secure it in the released position by tightening the belt tensioner adjustment bolt.



3. Remove the timing belt.



To install the timing belt, refer to Base Procedure 12—Assembly.

ENGINE COMPONENT DISASSEMBLY

BASE PROCEDURE 13—DISASSEMBLY CAMSHAFT SPROCKET OR SEAL REMOVAL

First complete:

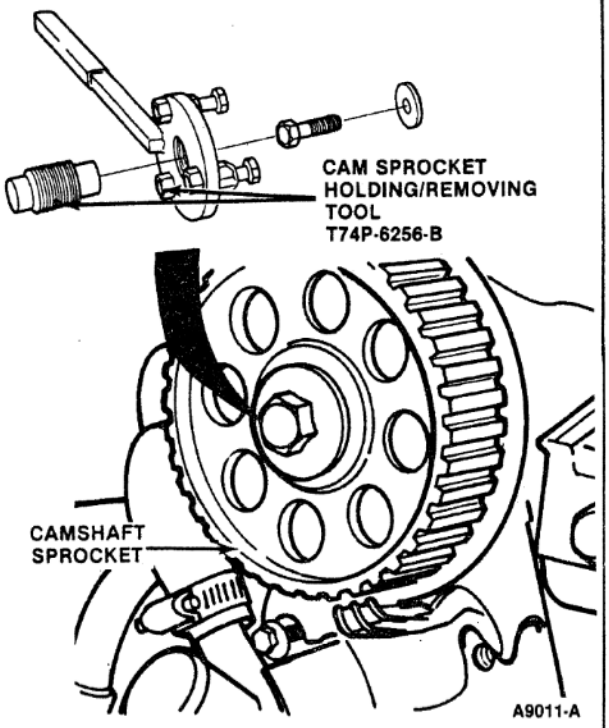
- Base Procedure 5—Disassembly, Drive Belts Removal
- Base Procedure 6—Disassembly, Water Pump Pulley Removal
- Base Procedure 7—Disassembly, Timing Belt Cover Removal
- Base Procedure 14—Disassembly, Crankshaft Damper and Pulley Removal
- Base Procedure 12—Disassembly, Timing Belt Removal

Then, proceed with the following:

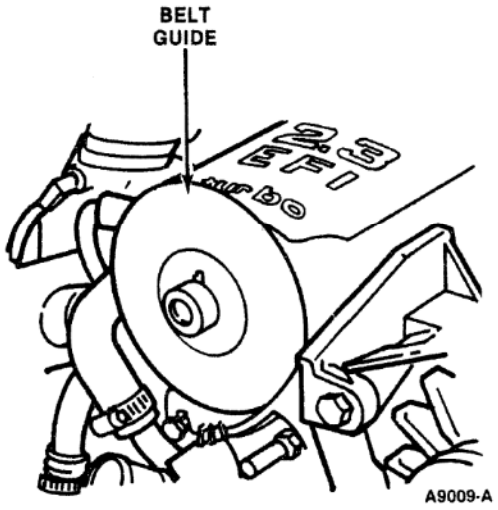
SPECIAL SERVICE TOOLS REQUIRED:

Cam Sprocket Holding/Removing Tool	T74P-6256-B
Front Cover Seal Remover	T74P-6700-B

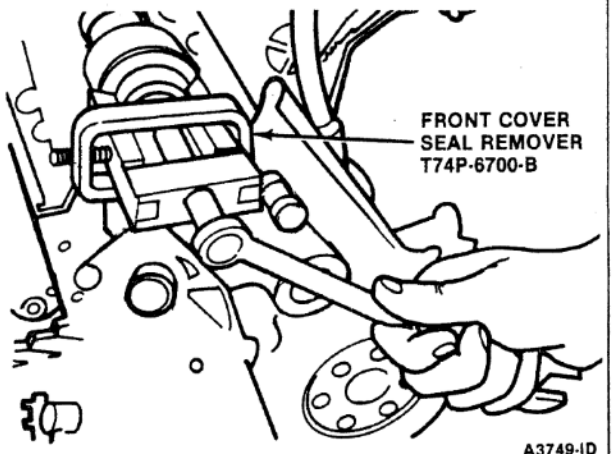
1. Remove the camshaft sprocket, using Cam Sprocket Holding/Removing Tool T74P-6256-B, or equivalent.



2. Remove the camshaft sprocket belt guide.



3. Remove the camshaft seal, using Front Cover Seal Remover T74P-6700-B, or equivalent.



To install the camshaft sprocket or seal, refer to Base Procedure 13—Assembly.

ENGINE COMPONENT DISASSEMBLY

BASE PROCEDURE 14—DISASSEMBLY CRANKSHAFT DAMPER AND PULLEY REMOVAL

First complete:

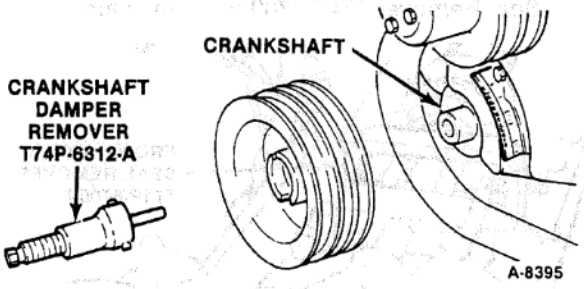
- Base Procedure 5—Disassembly, Drive Belts Removal

Then, proceed with the following:

SPECIAL SERVICE TOOL REQUIRED:

Crankshaft Damper Remover T74P-6312-A

1. Remove the crankshaft damper and pulley bolt.
2. Using Crankshaft Damper Remover T74P-6312-A, or equivalent, remove the crankshaft damper and pulley.



To install the crankshaft damper and pulley, refer to Base Procedure 14—Assembly.

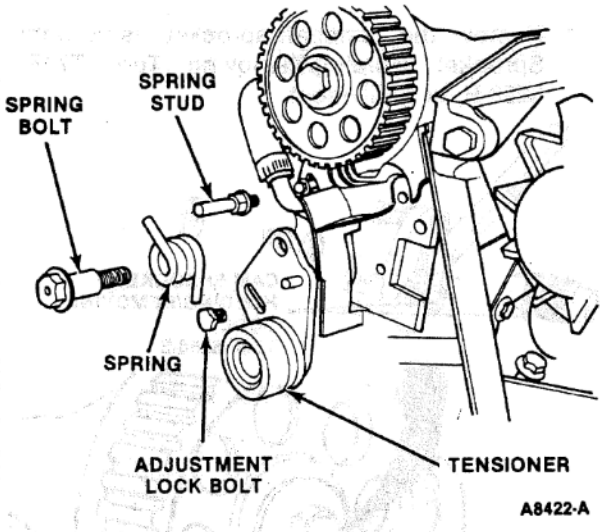
BASE PROCEDURE 15—DISASSEMBLY TIMING BELT TENSIONER REMOVAL

First complete:

- Base Procedure 5—Disassembly, Drive Belts Removal
- Base Procedure 6—Disassembly, Water Pump Pulley Removal
- Base Procedure 7—Disassembly, Timing Belt Cover Removal
- Base Procedure 14—Disassembly, Crankshaft Damper and Pulley Removal
- Base Procedure 12—Disassembly, Timing Belt Removal

Then, proceed with the following:

1. Remove the timing belt tensioner adjustment and spring retaining bolts.



2. Remove the timing belt tensioner.

To install the belt tensioner, refer to Base Procedure 15—Assembly.

ENGINE COMPONENT DISASSEMBLY

BASE PROCEDURE 16—DISASSEMBLY AUXILIARY SHAFT SPROCKET SEAL OR SHAFT REMOVAL

First complete:

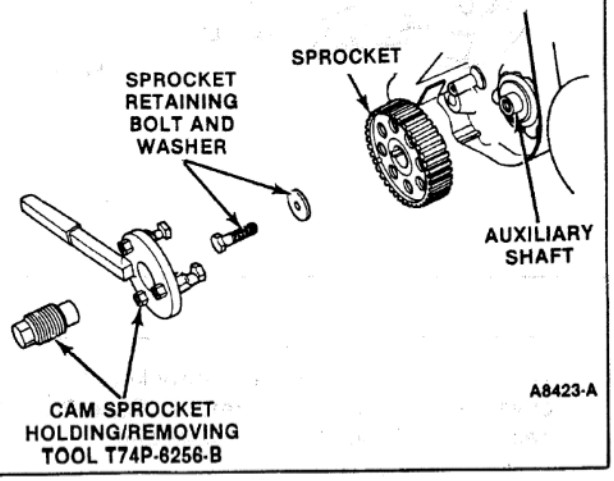
- Base Procedure 5—Disassembly, Drive Belts Removal
- Base Procedure 6—Disassembly, Water Pump Pulley Removal
- Base Procedure 7—Disassembly, Timing Belt Cover Removal
- Base Procedure 14—Disassembly, Crankshaft Damper and Pulley Removal
- Base Procedure 12—Disassembly, Timing Belt Removal

Then, proceed with the following:

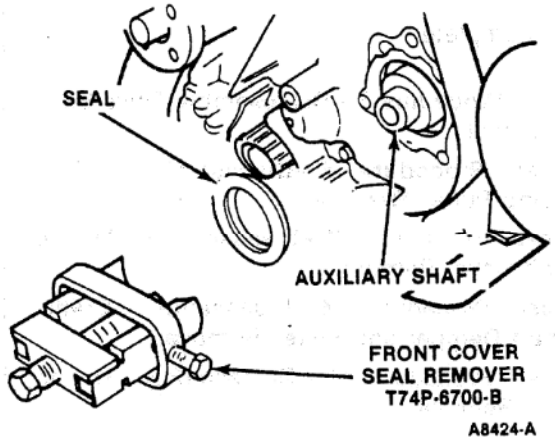
SPECIAL SERVICE TOOLS REQUIRED:

Cam Sprocket Holding/ Removing Tool	T74P-6256-B
Front Cover Seal Remover	T74P-6700-B

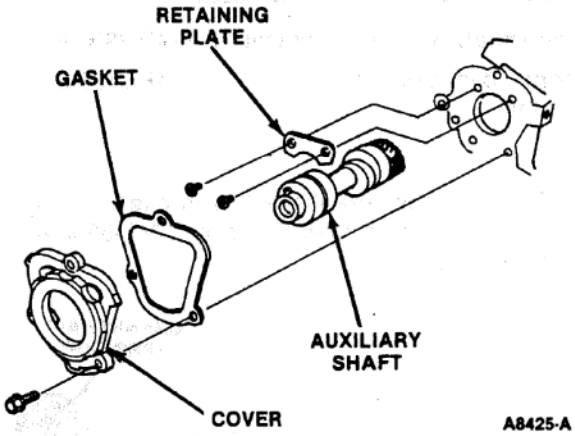
1. Remove the auxiliary shaft sprocket using Camshaft Sprocket Holding/Removing Tool T74P-6256-B.



2. Remove the auxiliary shaft seal using Front Cover Seal Remover T74P-6700-B, or equivalent.



3. Remove the auxiliary shaft cover.



4. Remove the auxiliary shaft, being careful not to scratch the bearings.

To install the auxiliary shaft sprocket or seal, refer to Base Procedure 16—Assembly.

ENGINE COMPONENT DISASSEMBLY

BASE PROCEDURE 17—DISASSEMBLY CRANKSHAFT SPROCKET, FRONT COVER SEAL OR COVER REMOVAL

First complete:

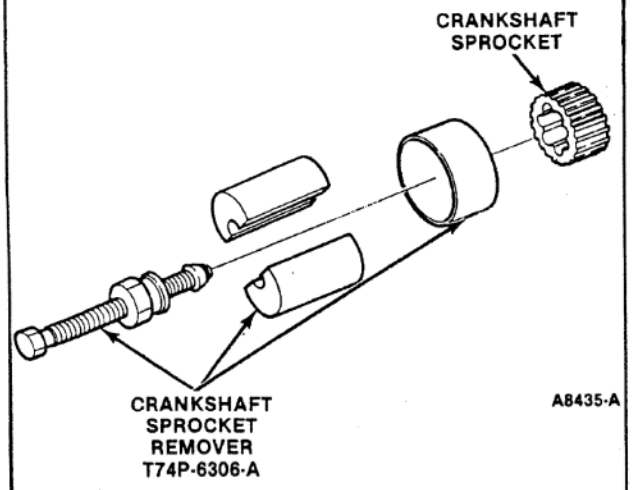
- Base Procedure 5—Disassembly, Drive Belts Removal
- Base Procedure 6—Disassembly, Water Pump Pulley Removal
- Base Procedure 7—Disassembly, Timing Belt Cover Removal
- Base Procedure 14—Disassembly, Crankshaft Damper and Pulley Removal
- Base Procedure 12—Disassembly, Timing Belt Removal

Then, proceed with the following:

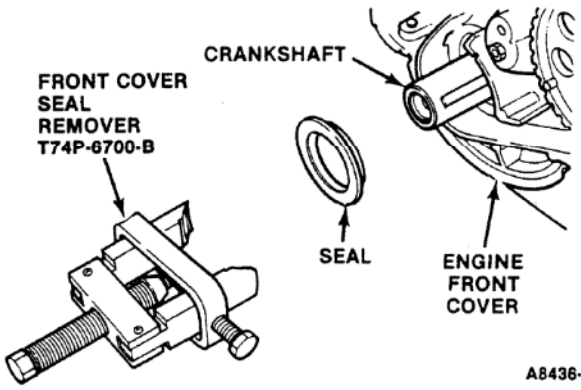
SPECIAL SERVICE TOOLS REQUIRED:

Crankshaft Sprocket Remover	T74P-6306-A
Front Cover Seal Remover	T74P-6700-B

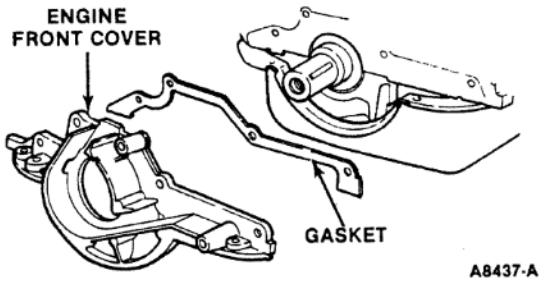
1. Remove the crankshaft sprocket, using Crankshaft Sprocket Remover T74P-6306-A, or equivalent.



2. Remove the front cover seal, using Front Cover Seal Remover T74P-6700-B, or equivalent.



3. Remove the engine front cover.



To install the crankshaft sprocket, front cover seal or front cover, refer to Base Procedure 17—Assembly, in this section.

ENGINE COMPONENT DISASSEMBLY

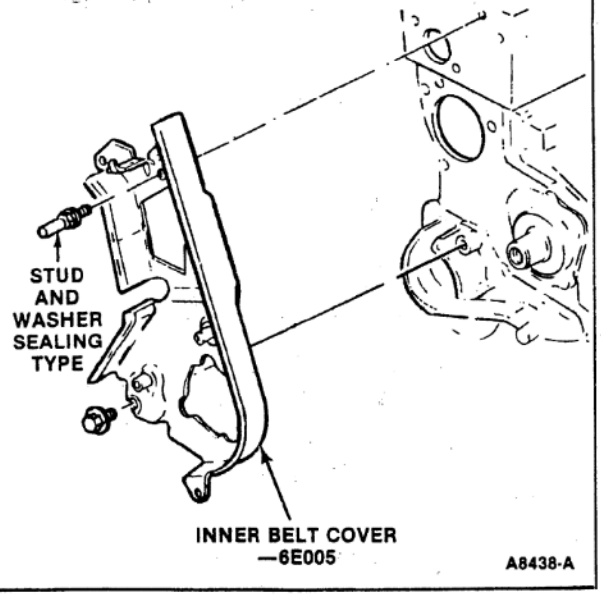
BASE PROCEDURE 18—DISASSEMBLY TIMING BELT INNER COVER REMOVAL

First complete:

- Base Procedure 5—Disassembly, Drive Belts Removal
- Base Procedure 6—Disassembly, Water Pump Pulley Removal
- Base Procedure 7—Disassembly, Timing Belt Cover Removal
- Base Procedure 14—Disassembly, Crankshaft Damper and Pulley Removal
- Base Procedure 12—Disassembly, Timing Belt Removal
- Base Procedure 13—Disassembly, Camshaft Sprocket Removal
- Base Procedure 15—Disassembly, Timing Belt Tensioner Removal
- Base Procedure 16—Disassembly, Auxiliary Sprocket Removal

Then, proceed with the following:

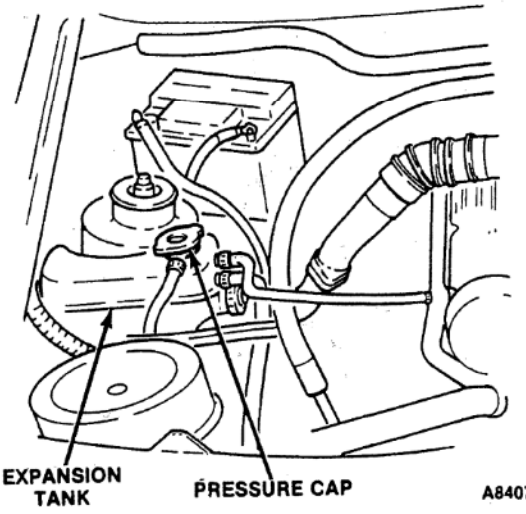
1. Remove the attaching bolts and the timing belt inner cover.



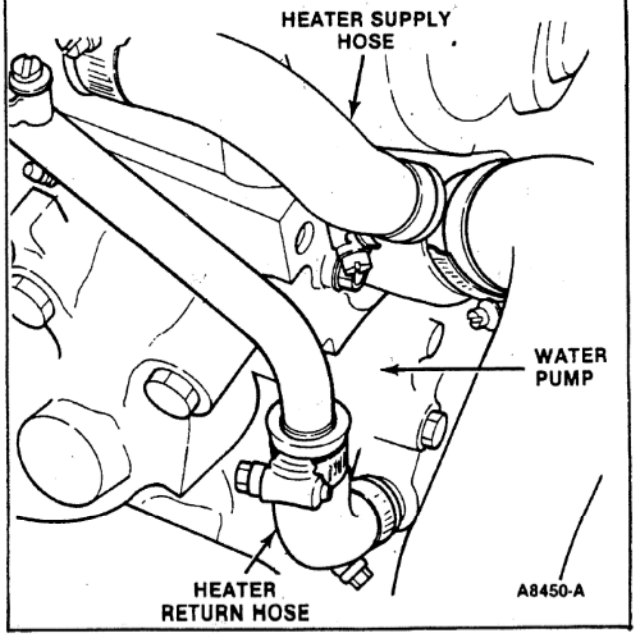
To install the timing belt inner cover, refer to Base Procedure 18—Assembly.

BASE PROCEDURE 19—DISASSEMBLY EXHAUST MANIFOLD REMOVAL

1. Loosen the cap on the coolant expansion tank. Drain the coolant from the radiator. If necessary, refer to Section 27-03 for the radiator drain location.



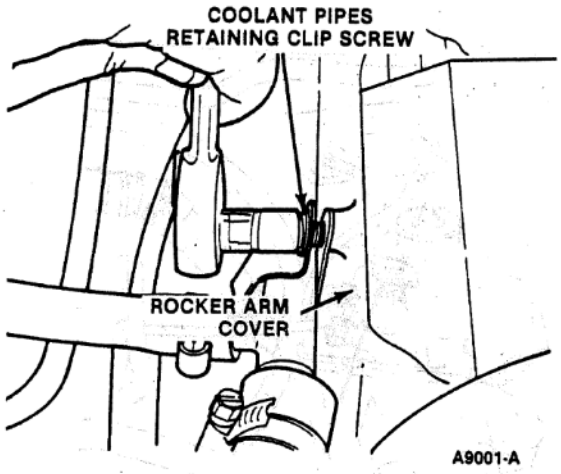
2. Remove the heater return hose at the water pump.



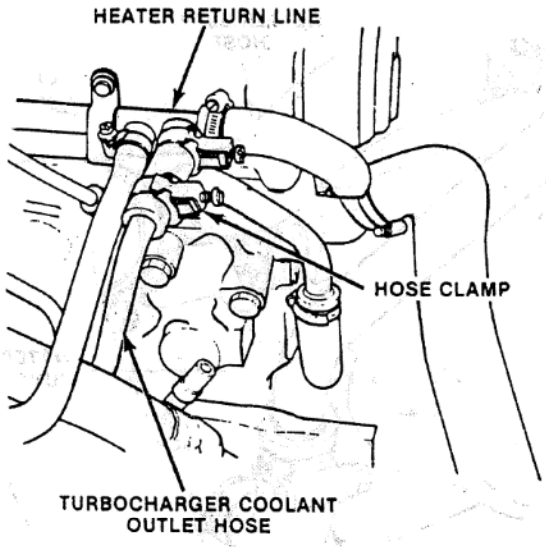
ENGINE COMPONENT DISASSEMBLY

BASE PROCEDURE 19—DISASSEMBLY
EXHAUST MANIFOLD REMOVAL (Continued)

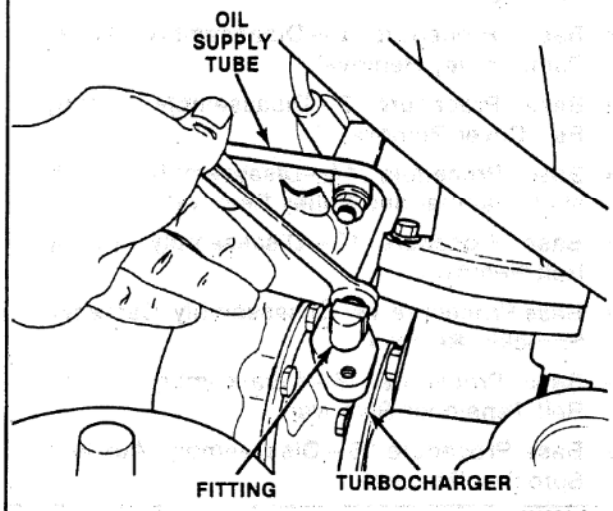
3. Remove the screw attaching the coolant pipe routing bracket to the right front side of the valve cover.



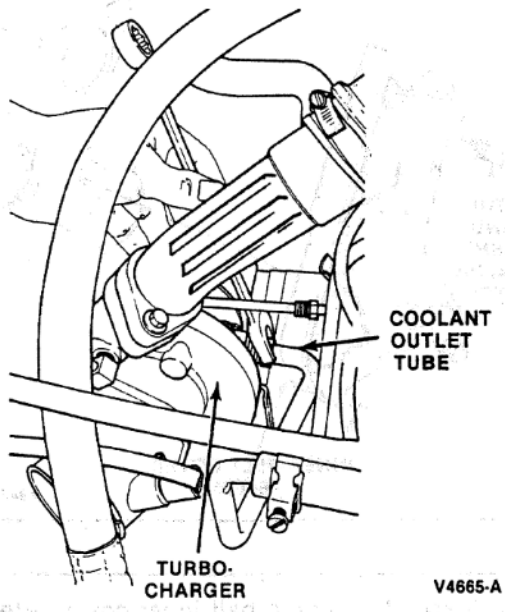
4. Disconnect the coolant pipe-to-expansion tank hose at the coolant pipe.



5. Disconnect the turbocharger oil supply line at the turbocharger.



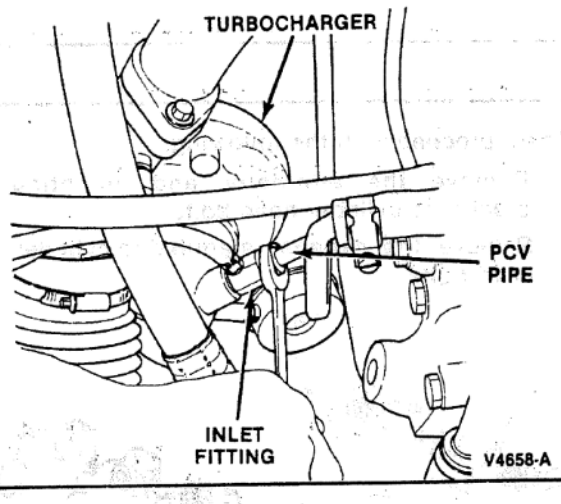
6. Disconnect the turbocharger coolant supply and return tube at the turbocharger.



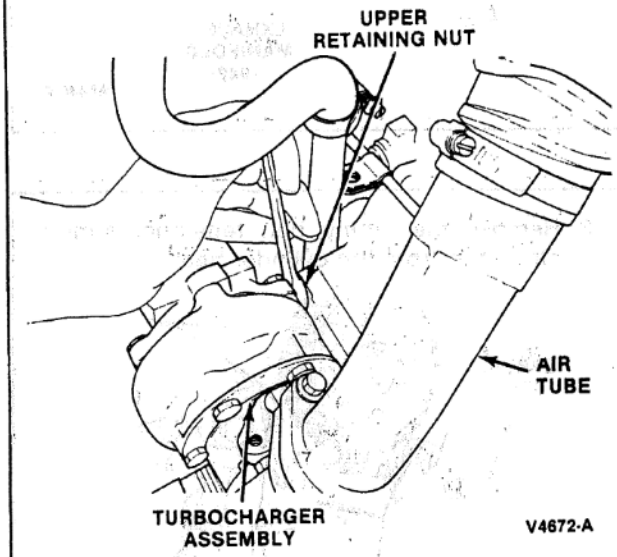
ENGINE COMPONENT DISASSEMBLY

BASE PROCEDURE 19—DISASSEMBLY
EXHAUST MANIFOLD REMOVAL (Continued)

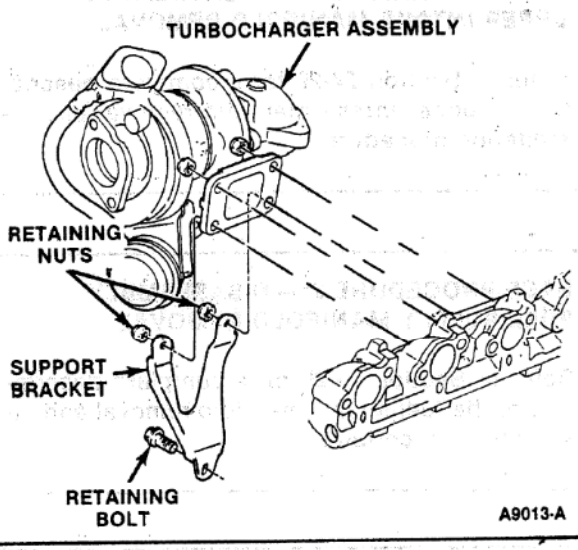
7. Disconnect the PCV tube at the turbo air inlet adapter.



8. Remove the turbo-to-exhaust manifold attaching nuts.

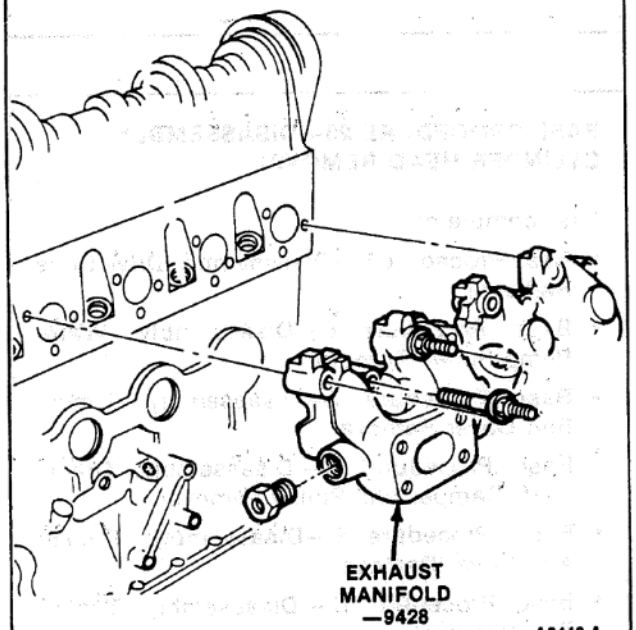


9. Remove the turbo support bracket.



10. Remove the exhaust manifold-to-cylinder head attaching bolts.

11. Remove the exhaust manifold.



To install the exhaust manifold, refer to Base Procedure 19—Assembly.

ENGINE COMPONENT DISASSEMBLY

BASE PROCEDURE 20—DISASSEMBLY UPPER INTAKE MANIFOLD REMOVAL

Refer to Section 24-29 for a complete description of upper intake manifold removal and installation procedure.

BASE PROCEDURE 21—DISASSEMBLY FUEL SUPPLY MANIFOLD REMOVAL

Refer to Section 24-29 for a complete description of the fuel supply manifold removal and installation procedure.

BASE PROCEDURE 22—DISASSEMBLY LOWER INTAKE MANIFOLD REMOVAL

Refer to Section 24-29 for a complete description of the lower intake manifold removal and installation procedure.

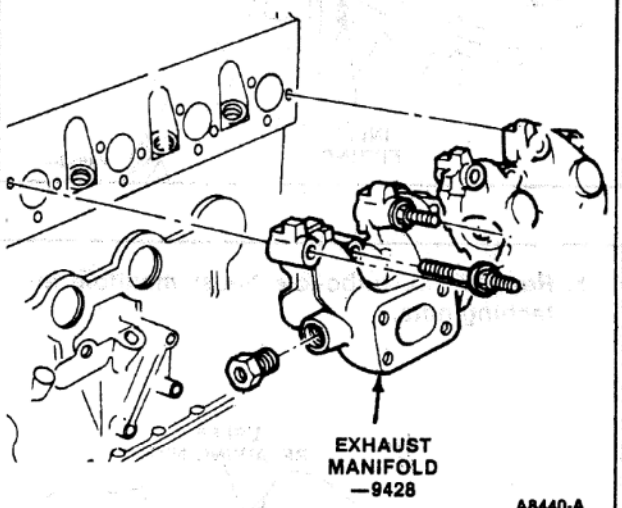
BASE PROCEDURE 23—DISASSEMBLY CYLINDER HEAD REMOVAL

First complete:

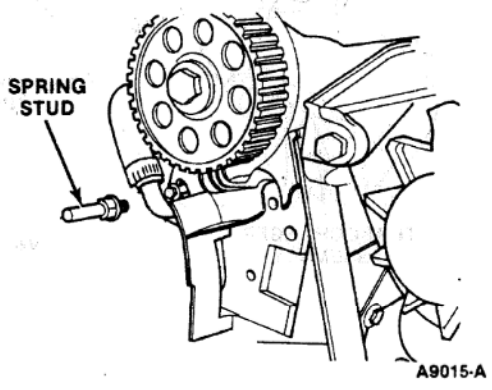
- Base Procedure 5—Disassembly, Drive Belts Removal
- Base Procedure 6—Disassembly, Water Pump Pulley Removal
- Base Procedure 7—Disassembly, Timing Belt Cover Removal
- Base Procedure 14—Disassembly, Crankshaft Damper and Pulley Removal
- Base Procedure 9—Disassembly, Rocker Arm Cover Removal
- Base Procedure 12—Disassembly, Timing Belt Removal
- Base Procedure 13—Disassembly, Camshaft Sprocket Removal
- Base Procedure 15—Disassembly, Timing Belt Tensioner Removal
- Base Procedure 18—Disassembly, Timing Belt Inner Cover Removal

Then, proceed with the following:

1. Remove the alternator and mounting bracket-to-cylinder head bolts.
2. Remove the exhaust manifold-to-cylinder head bolts.

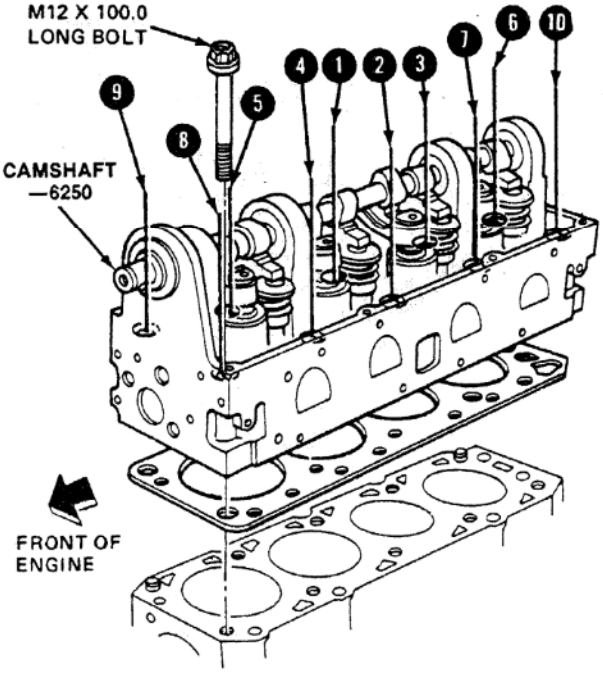


3. Remove the timing belt tensioner spring stop stud from the cylinder head.



ENGINE COMPONENT DISASSEMBLY (Continued)

4. Remove the cylinder head attaching bolts.
5. Remove the cylinder head.



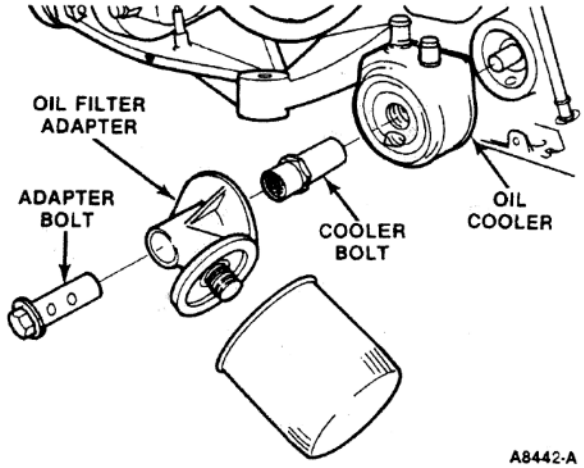
To install the cylinder head, refer to Base Procedure 23—Assembly.

Base Procedure 24—Disassembly Oil Filter and Cooler Removal

SPECIAL SERVICE TOOL REQUIRED:

Oil Filter Wrench D79L-6731-B

1. Drain the cooling system.
2. Remove the oil filter using Oil Filter Wrench D79L-6731-B, or equivalent.
3. Remove the oil cooler water hoses at the oil cooler.
4. Remove the oil filter adapter bolt and adapter.



5. Remove the oil cooler bolt and cooler.

To install the oil cooler and filter, refer to Base Procedure 24—Assembly.

ENGINE COMPONENT DISASSEMBLY (Continued)

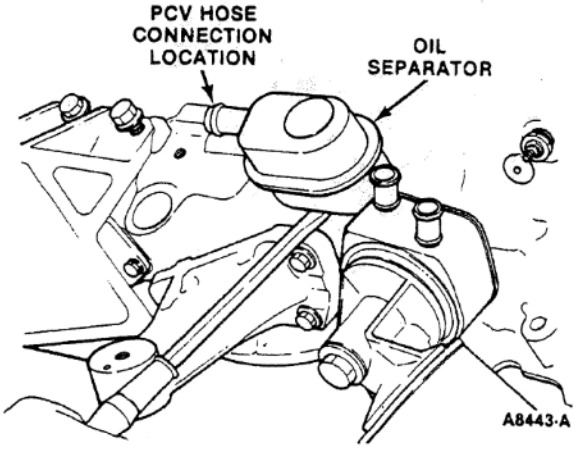
Base Procedure 25—Disassembly Oil Separator Removal

First complete:

- Base Procedure 21—Disassembly, Fuel Charging Assembly Removal. Refer to Section 24-29.

Then proceed with the following:

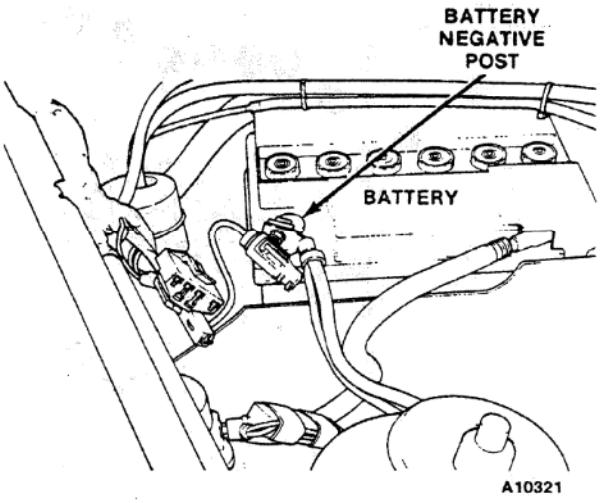
1. Disconnect the hose from the oil separator.
2. Pry the oil separator from the cylinder block. Loctite is used to retain the separator in the block, so extra care should be used during removal.



To install the oil separator, refer to Base Procedure 25—Assembly.

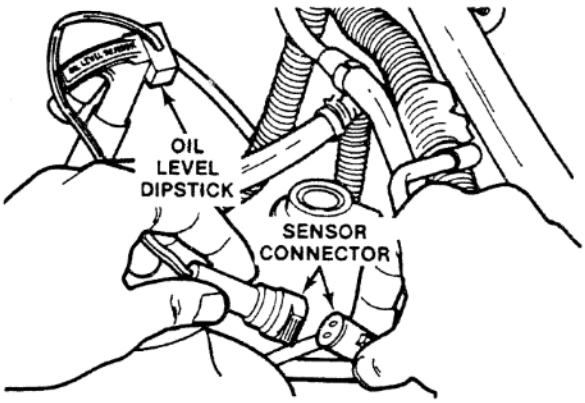
Base Procedure 26—Disassembly Oil Pan/ Gasket Removal

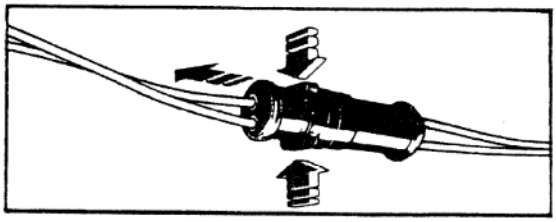
1. Disconnect the battery negative cable.



2. Separate the oil level sensor wiring connector and remove the engine oil level dipstick.

   NOTE: Electrical connector at oil dipstick applies to all units built prior to 3-9-87.

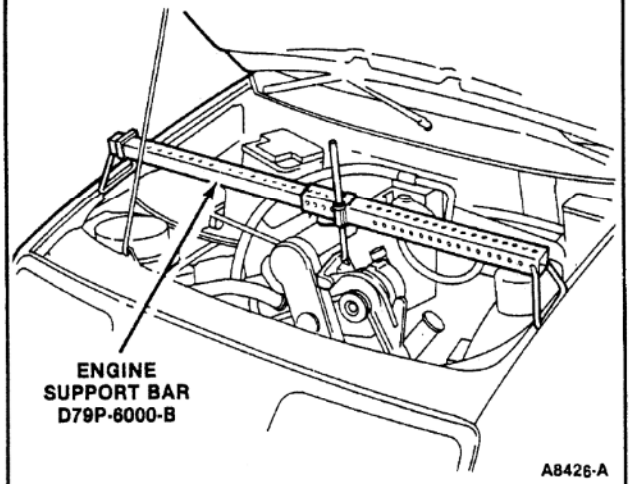




ENGINE COMPONENT DISASSEMBLY

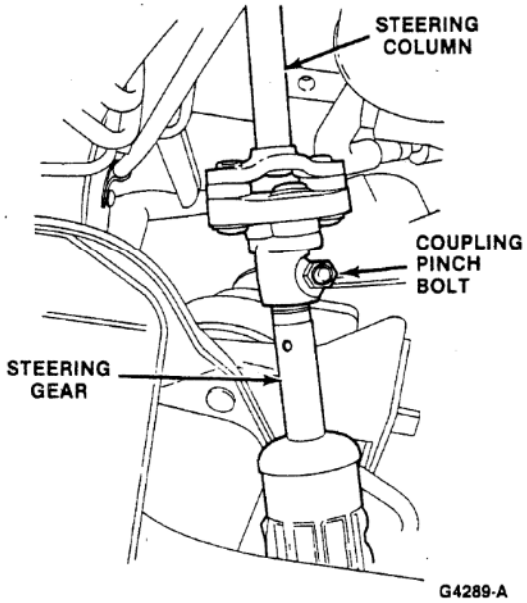
BASE PROCEDURE 26—DISASSEMBLY
OIL PAN/GASKET REMOVAL (Continued)

3. Install a suitable engine support fixture.

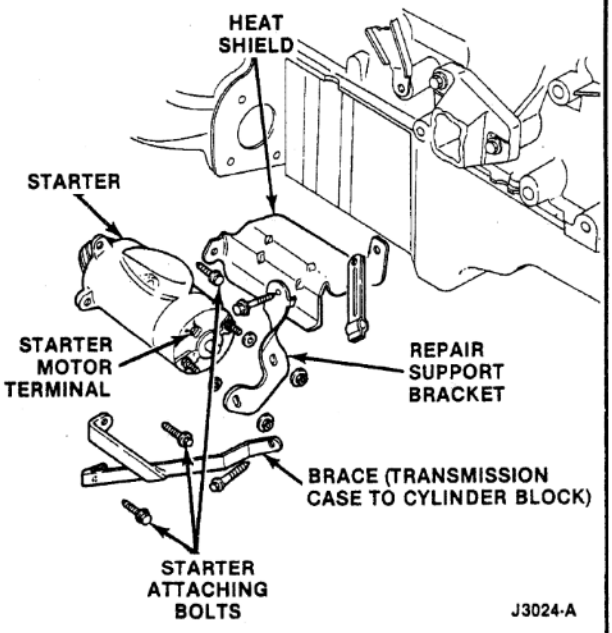


4. Raise the vehicle.
5. Drain the engine oil.

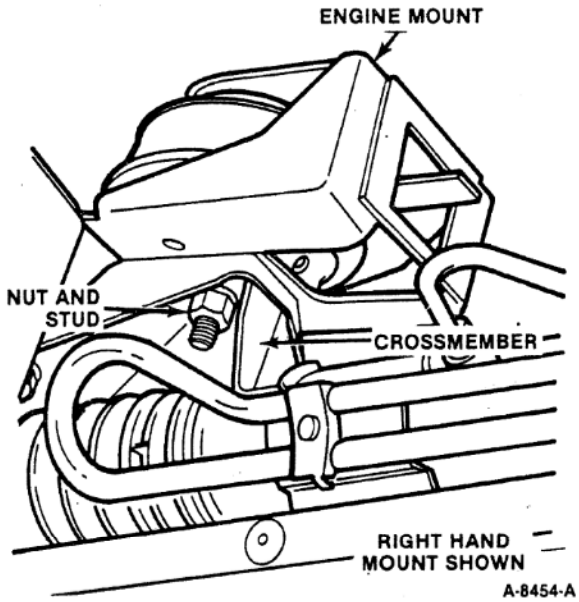
7. Remove the pinch bolt at the steering column-to-steering gear coupling.



6. Remove the starter. If necessary, refer to Section 28-02.



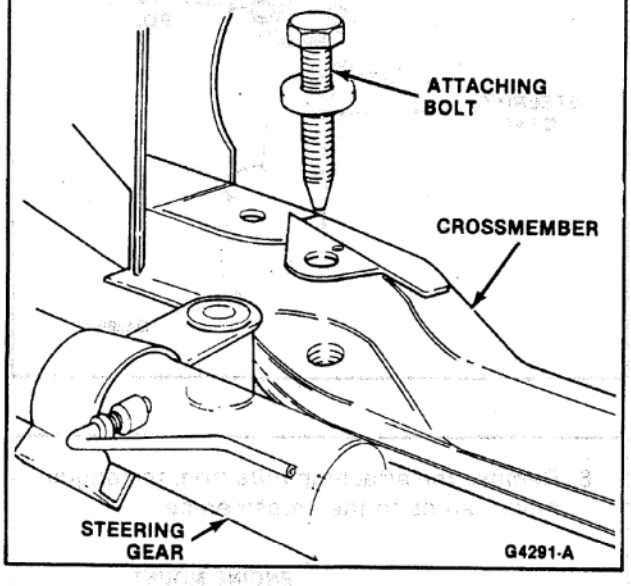
8. Remove the attaching nuts from the engine mount studs to the crossmember.



ENGINE COMPONENT DISASSEMBLY

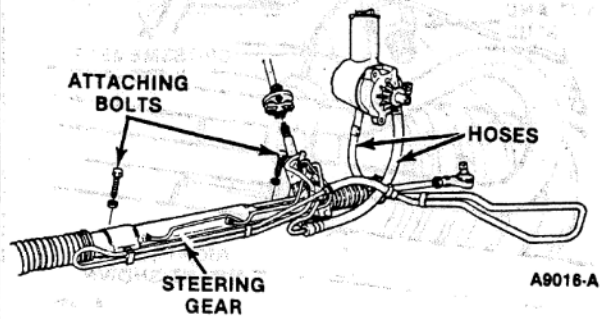
BASE PROCEDURE 26—DISASSEMBLY
OIL PAN/GASKET REMOVAL (Continued)

9. Lower the vehicle.
10. Using the support fixture, raise the engine as far as possible.
11. Raise the vehicle.
12. Remove the steering gear-to-crossmember attaching bolts.

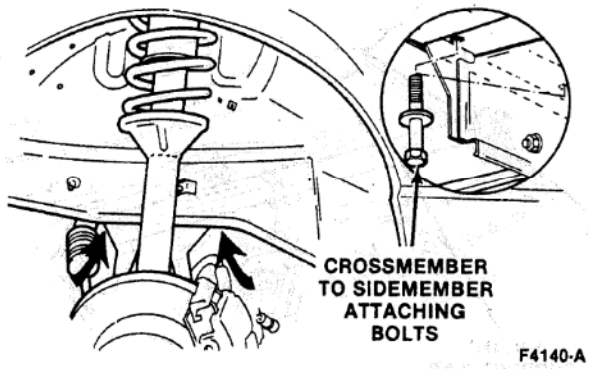


13. Disengage the steering gear from the steering column and pull forward, away from the crossmember.

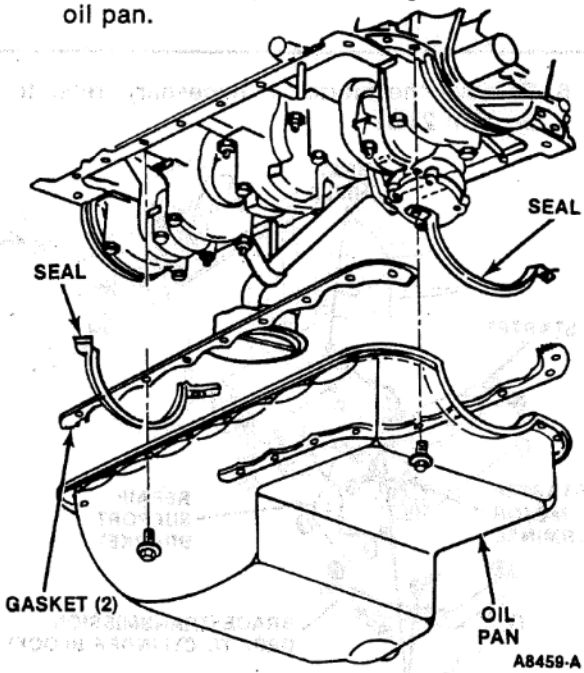
    Use care to prevent stretching or bending the power steering gear hoses and lines.



14. Position a transmission jack under the crossmember.
15. Remove the crossmember-to-side rail attaching bolts.



16. Lower the transmission jack and crossmember.
17. Remove the oil pan attaching bolts and the oil pan.



To install the oil pan, refer to Base Procedure 26—Assembly.

ENGINE COMPONENT DISASSEMBLY

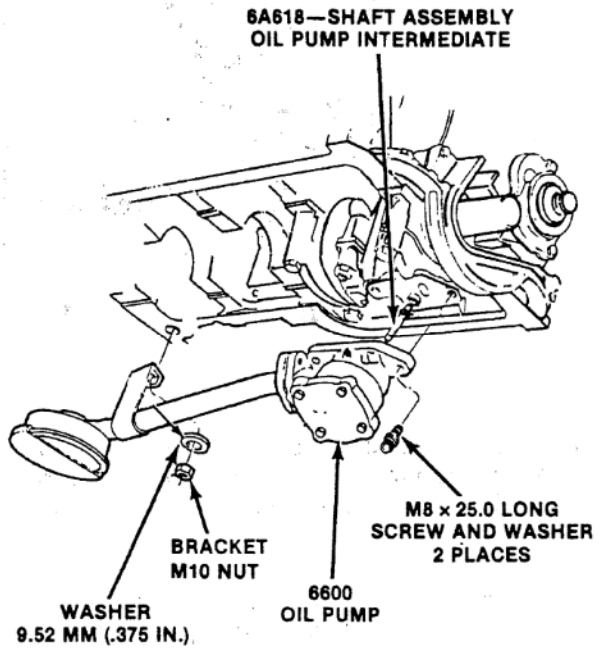
BASE PROCEDURE 27—DISASSEMBLY OIL PUMP REMOVAL

First complete the following:

- Base Procedure 26—Disassembly, Oil Pan Removal

Then, proceed with the following:

1. Remove the oil pickup tube and screen support bracket nut from the No. 4 main bearing cap.
2. Remove the two oil pump attaching screws and remove the oil pump.



3. Remove the oil pump intermediate shaft.

To install the oil pump, refer to Base Procedure 27—Disassembly.

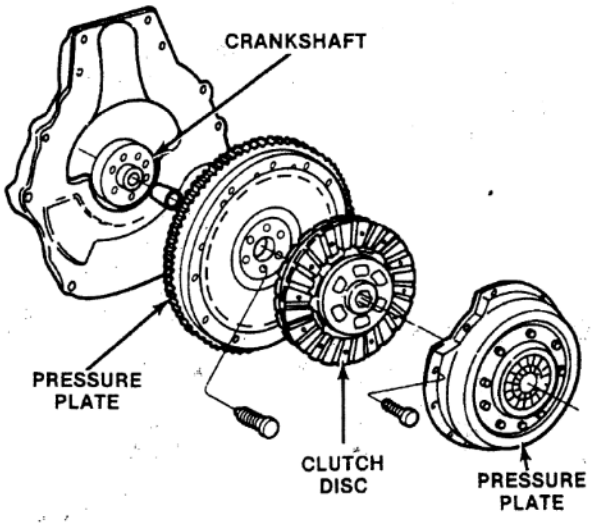
BASE PROCEDURE 28—DISASSEMBLY FLYWHEEL REMOVAL

First complete the following:

- Remove the transmission. If equipped with a manual transmission, refer to Section 16-33. If equipped with an automatic transmission, refer to Section 17-03.

Then, proceed with the following:

1. If equipped with a manual transmission, remove the clutch pressure and friction plates. Refer to Section 16-02.
2. Remove the flywheel-to-crankshaft attaching bolts and remove the flywheel.



To install the flywheel, refer to Base Procedure 29—Assembly.

ENGINE COMPONENT DISASSEMBLY

BASE PROCEDURE 29—DISASSEMBLY CONNECTING ROD AND PISTON REMOVAL

First complete:

- Base Procedure 23—Disassembly, Cylinder Head Removal
- Base Procedure 26—Disassembly, Oil Pan Removal

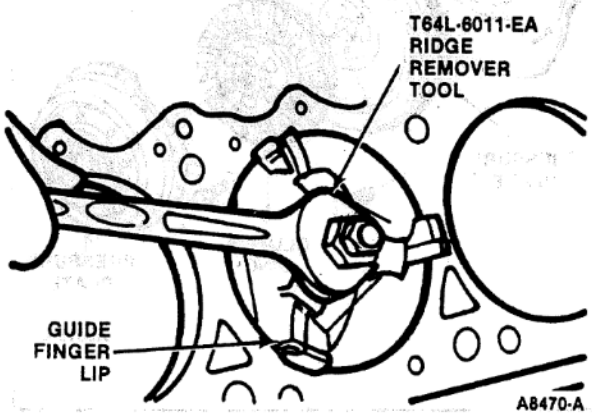
Then, proceed with the following:

SPECIAL SERVICE TOOLS REQUIRED:

Cylinder Ridge Reamer T64L-6011-EA

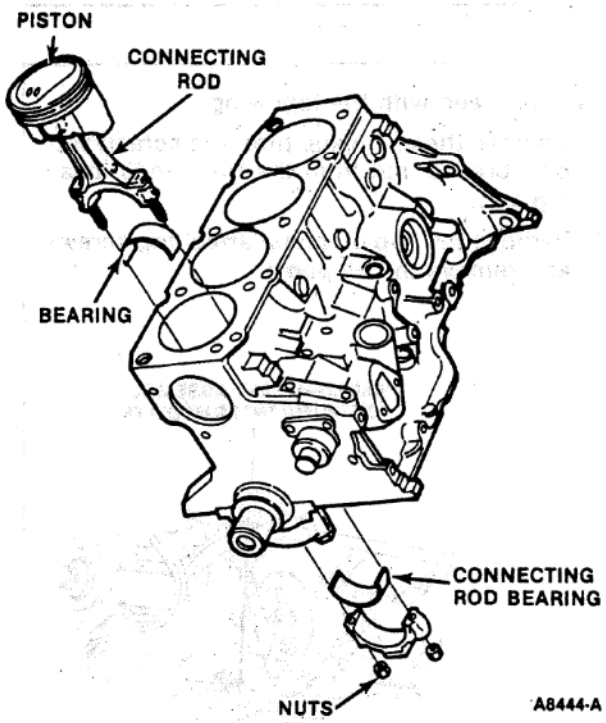
1. Turn the crankshaft until the connecting rod to be removed is in a down position.
2. Remove the carbon from the upper portion of the cylinder bore. If a ridge can be felt or seen at the top of the bore, it must be removed.
3. If necessary, install the Cylinder Ridge Reamer T64L-6011-EA, or equivalent, in the cylinder bore.

   Following directions of the ridge reamer manufacturer, remove the ridge until the bore is straight to the top edge of the cylinder.



4. Repeat steps 1 through 3 as necessary.

5. Remove the connecting rod nuts.
6. Remove the rod cap and bearing half.



7. Using a hammer handle or piece of wood or plastic, tap the rod and piston upward until the piston rings clear the top of the cylinder block.
8. Remove the rod and piston assembly from the top of the cylinder bore.
9. Repeat Steps 1 through 8 as required.

To install the connecting rod and piston, refer to Base Procedure 29—Assembly, in this section.

ENGINE COMPONENT DISASSEMBLY

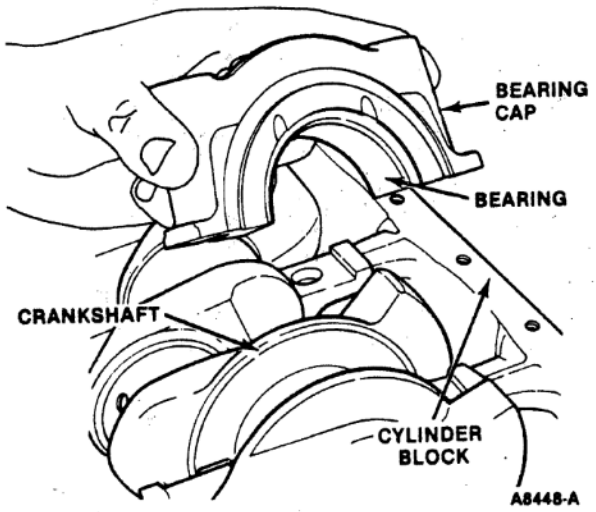
BASE PROCEDURE 30—DISASSEMBLY CRANKSHAFT MAIN BEARING INSERTS REMOVAL

First complete the following:

- Remove the starter. Refer to Section 28-02.
- Base Procedure 26—Disassembly, Oil Pan Removal
- Base Procedure 27—Disassembly, Oil Pump Removal

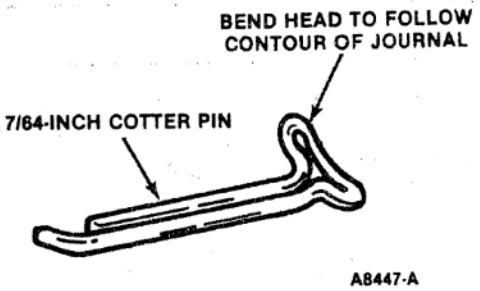
Then, proceed with the following:

1. Remove the main bearing cap attaching bolts.



CAUTION: If bearing inserts are to be replaced with the engine in the vehicle, keep at least two main bearing caps tight while servicing the others.

2. Remove the main bearing caps and bearing inserts.
3. Remove the upper bearing inserts, using a bearing removing tool or a bent cotter key. Insert the tool or key in the crankshaft journal oil hole and turn the crankshaft in the normal direction of rotation to remove the upper bearing half.



CAUTION: Always turn the crankshaft clockwise, which is the normal direction of rotation. Reverse rotation may cause the timing belts to jump time due to the arrangement of the belt tensioner.

4. If the bearing clearance is to be measured in the vehicle with Plastigage, then support the crankshaft with a piece of wood and a jack, or a false reading may result.

To install the main bearing inserts, refer to Base Procedure 30—Assembly.

ENGINE COMPONENT DISASSEMBLY

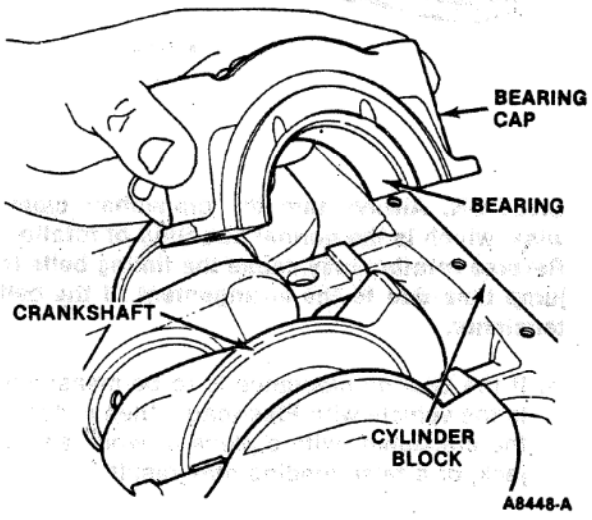
BASE PROCEDURE 31—DISASSEMBLY CRANKSHAFT REMOVAL

First complete the following:

- Remove the engine. If necessary, refer to the procedure in this section.
- Base Procedure 23—Disassembly, Cylinder Head Removal
- Base Procedure 26—Disassembly, Oil Pan Removal
- Base Procedure 27—Disassembly, Oil Pump Removal
- Base Procedure 29—Disassembly, Connecting Rod and Piston Removal
- Base Procedure 28—Disassembly, Flywheel Removal

Then, proceed with the following:

1. Remove the main bearing caps.



2. Remove the crankshaft, being careful not to damage the bearing journals.

To install the crankshaft, refer to Base Procedure 31—Assembly.

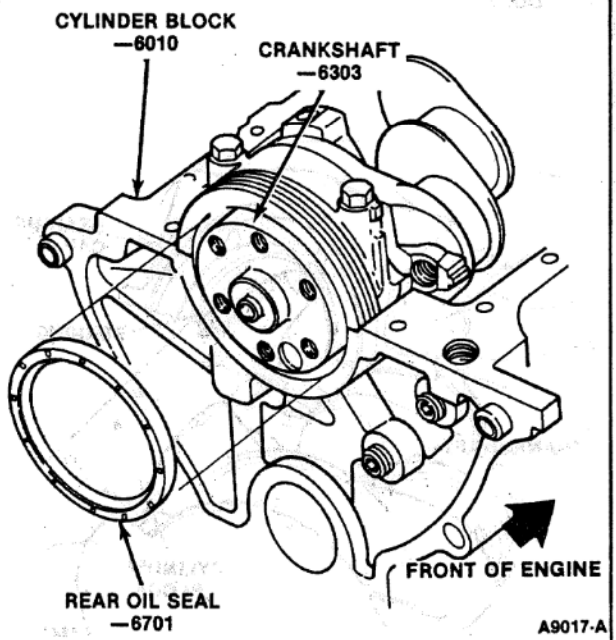
BASE PROCEDURE 32—DISASSEMBLY CRANKSHAFT REAR OIL SEAL REMOVAL

First complete the following:

- Remove the transmission. If equipped with a manual transmission, refer to Section 16-33. If equipped with an automatic transmission, refer to Section 17-03.
- Base Procedure 28—Disassembly, Flywheel Removal

Then, proceed with the following:

1. Punch a small hole in the metal portion of the rear face of the seal.
2. Install a sheet metal screw in the punched hole.
3. With the aid of a slide hammer or roll head pry bar, remove the seal.



To install the crankshaft rear oil seal, refer to Base Procedure 32—Assembly.

ENGINE COMPONENT ASSEMBLY

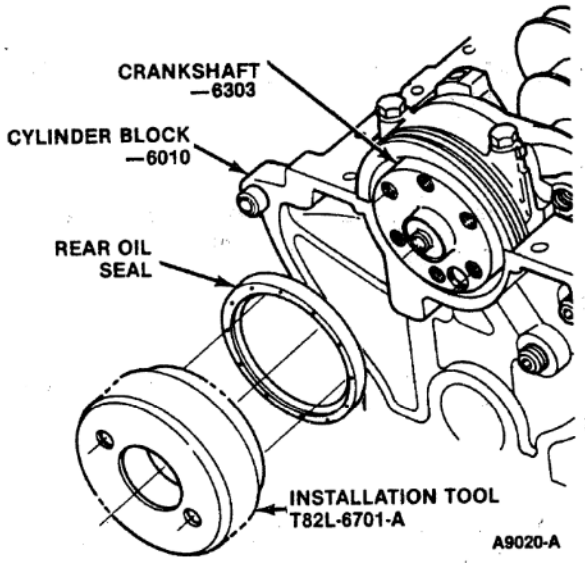
BASE PROCEDURE 32—ASSEMBLY

CRANKSHAFT REAR OIL SEAL INSTALLATION

SPECIAL SERVICE TOOL REQUIRED:

Rear Main Seal Installer T82L-6701-A

1. Clean the seal groove and the seal surface of the crankshaft.
2. Apply engine oil, XO-10-40-QSP, to the interior sealing lip of the seal and to the crankshaft seal surface.
3. Position seal onto Installer Tool T82L-6701-A.



4. Using two bolts supplied with the tool, or two flywheel bolts, pull the seal and tool onto the crankshaft by alternately tightening the bolts. Remove the bolts and the tool.

Then complete:

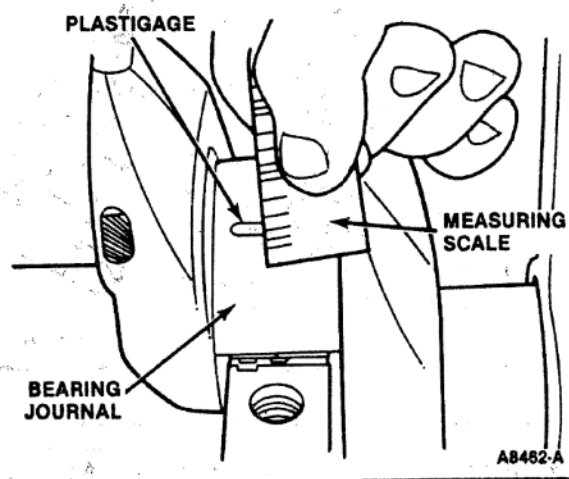
- Base Procedure 28—Assembly, Flywheel Installation
- Install the transmission. If equipped with a manual transmission, refer to Section 16-33. If equipped with an automatic transmission, refer to Section 17-03.

BASE PROCEDURE 31—ASSEMBLY

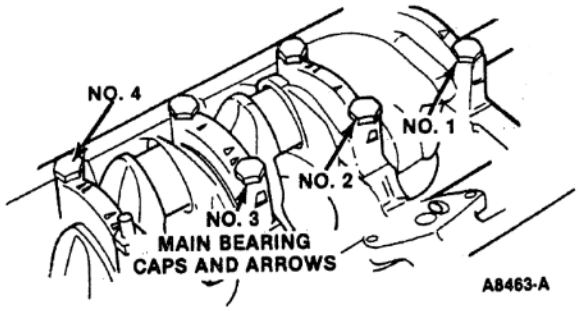
CRANKSHAFT INSTALLATION

1. After cleaning, inspecting and measuring the crankshaft (as described later in this section) install the proper size bearings in the cylinder block and bearing caps.

   Install the crankshaft. Use Plastigage to measure the clearance. Follow the instructions on the package. The clearance should be 0.020 to 0.066 mm (0.0008 to 0.0026 in.).



2. Be sure the bearing caps are in their proper position. Install the main bearing caps and tighten the bolts to 68 to 81 N·m(50 to 60 lb-ft).



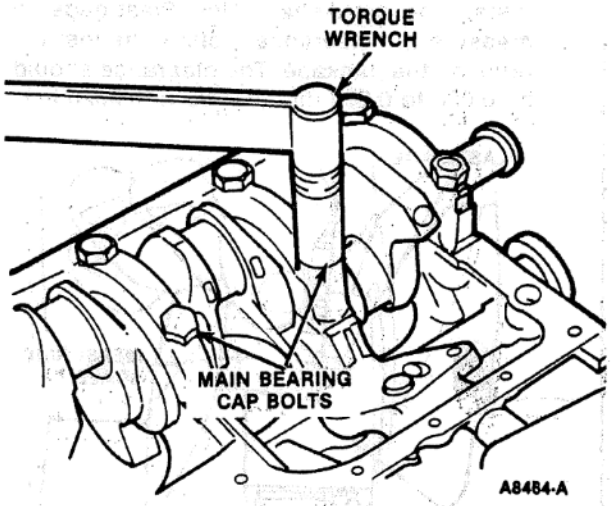
   After each cap is tightened, check to see and feel that the crankshaft can be rotated by hand. If not, remove that bearing cap and investigate for the source of interference.

ENGINE COMPONENT ASSEMBLY

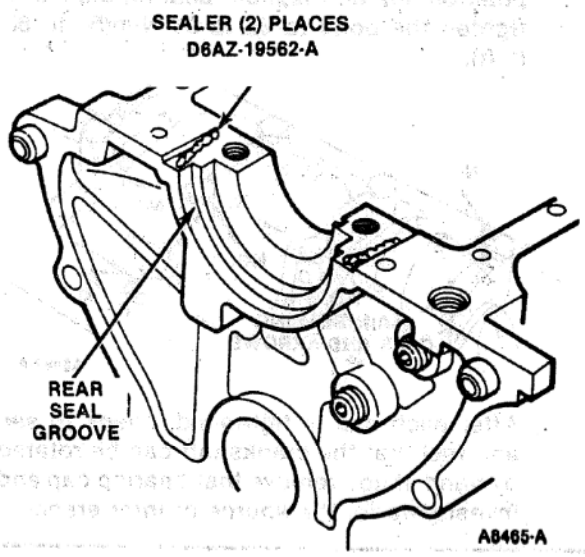
BASE PROCEDURE 31—ASSEMBLY

CRANKSHAFT INSTALLATION (Continued)

3. Torque all main bearing caps to 101 to 115 N·m (75 to 85 lb-ft). Check again for crankshaft rotation.



4. Remove the rear main bearing cap. Apply a 1/8 in. bead of D6AZ-19562-A or B sealer across the main bearing cap to cylinder block surface.



NOTE: Do not apply sealer onto bearing or rear seal surface of the crankshaft.

5. Install the rear cap and torque to 101 to 115 N·m (75 to 85 lb-ft) in two steps.

Then complete:

- Base Procedure 29—Assembly, Connecting Rods and Piston Installation
- Base Procedure 27—Assembly, Oil Pump Installation
- Base Procedure 32—Assembly, Crankshaft Rear Oil Seal Installation
- Base Procedure 26—Assembly, Oil Pan Installation
- Base Procedure 28—Assembly, Flywheel Installation
- Base Procedure 23—Assembly, Cylinder Head Installation
- Install the engine. If necessary, refer to the procedure in this section.

ENGINE COMPONENT ASSEMBLY

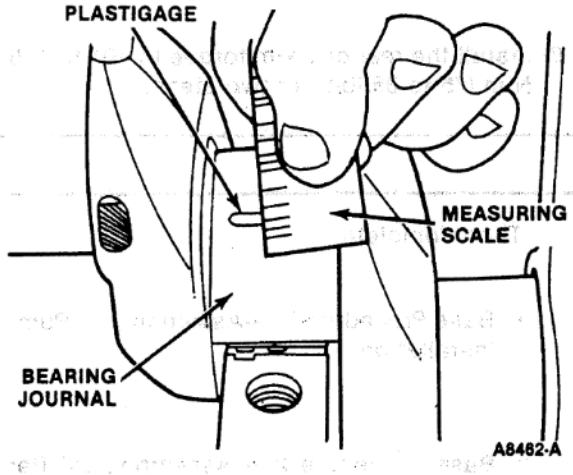
BASE PROCEDURE 30—ASSEMBLY

CRANKSHAFT MAIN BEARINGS INSTALLATION

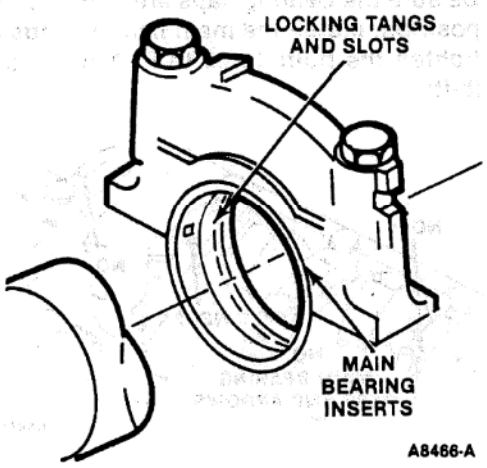
1. If the bearing clearance is to be measured in the chassis with Plastigage, support the crankshaft with a piece of wood and a jack, or a false reading may result.

2. After inspecting the crankshaft for nicks, scoring and wear, measure the crankshaft to select the proper bearing to crankshaft clearance (described later in this section). The clearance should be 0.020 to 0.066 mm (.0008 to .0026 in.).

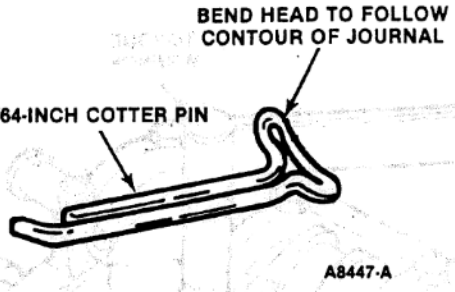
   Always keep at least two bearings and bearing caps tight while measuring the others.



3. Install the new bearings in the caps and cylinder block, matching the bearing tangs with the notch in the cap and block.



4. Use a bearing installing tool or a bent cotter key to help install the upper bearing half.



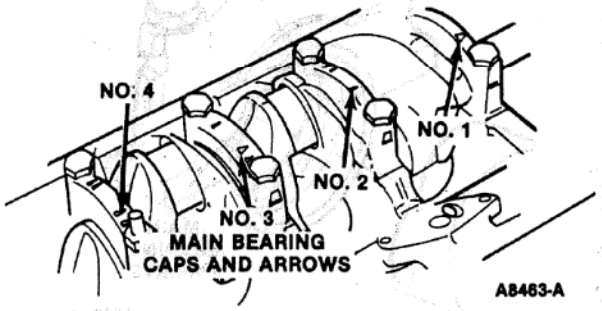
CAUTION: Always turn the engine in the normal direction of rotation to prevent the timing belt from jumping out of time and to prevent damage to the main bearings.

ENGINE COMPONENT ASSEMBLY

BASE PROCEDURE 30—ASSEMBLY

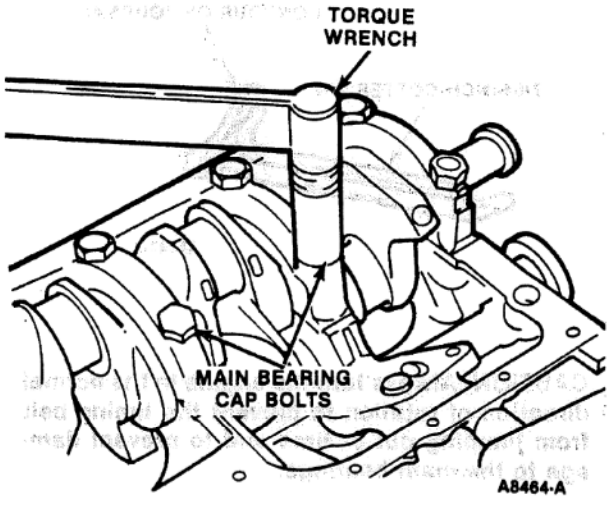
CRANKSHAFT MAIN BEARINGS INSTALLATION (Continued)

5. Be sure the bearing caps are in their proper position. Install the main bearing caps and tighten the bolts to 68 to 81 N·m (50 to 60 lb-ft).

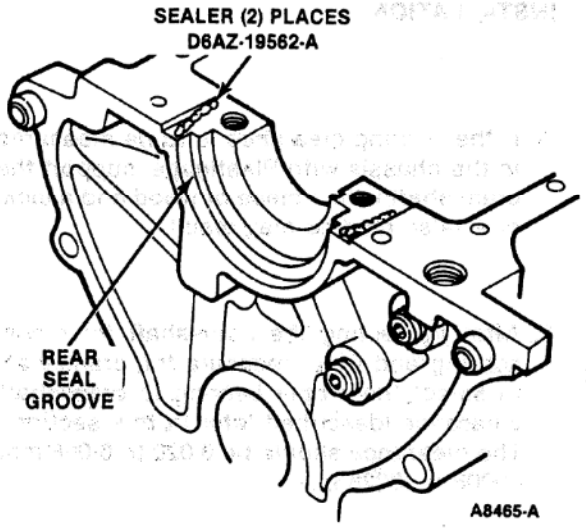


After each cap is tightened, check to see and feel that the crankshaft can be rotated by hand. If not, remove that bearing cap and investigate for the source of interference.

6. Torque all main bearing caps to 101 to 115 N·m (75 to 85 lb-ft). Check again for crankshaft rotation.



7. Remove the rear main bearing cap. Apply a 1/8 in. bead of D6AZ-19562-A or -B sealer across the main bearing cap to cylinder block surface.



NOTE: Do not apply sealer onto bearing or rear seal surface of the crankshaft.

8. Install the rear cap and torque to 101 to 115 N·m (75 to 85 lb-ft) in two steps.

Then complete:

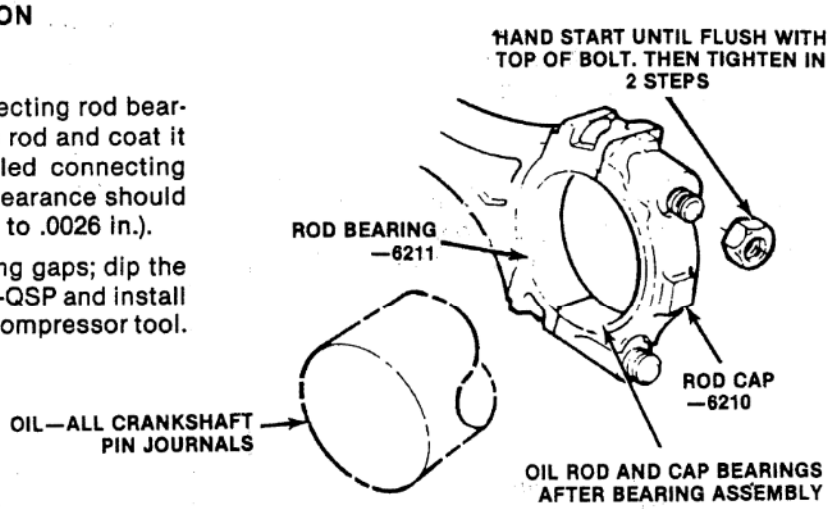
- Base Procedure 27—Assembly, Oil Pump Installation
- Base Procedure 26—Assembly, Oil Pan Installation

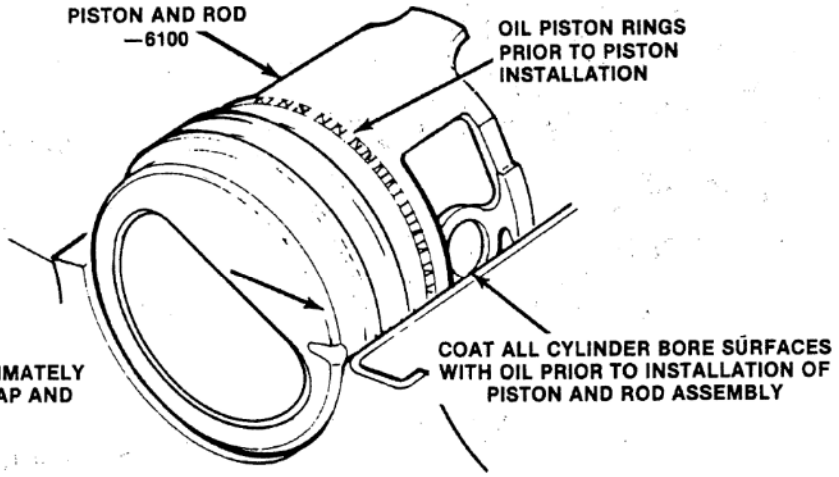
ENGINE COMPONENT ASSEMBLY

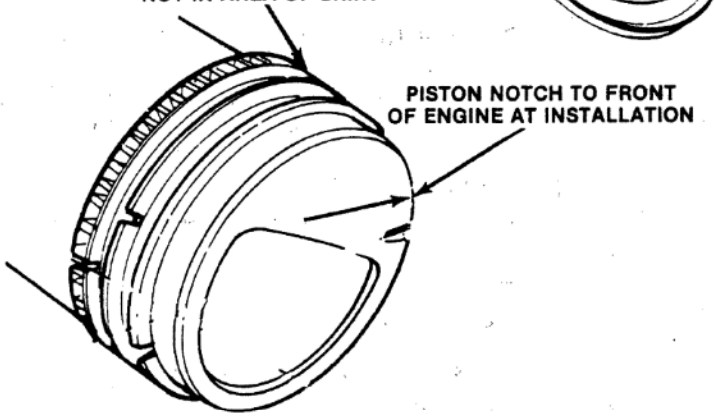
BASE PROCEDURE 29—ASSEMBLY

CONNECTING ROD AND PISTON INSTALLATION

1. Install the proper size connecting rod bearing half into the connecting rod and coat it with engine oil. The installed connecting rod bearing to crankshaft clearance should be 0.020 to 0.066 mm (.0008 to .0026 in.).
2. Properly space the piston ring gaps; dip the piston in engine oil XO-10-40-QSP and install and tighten the piston ring compressor tool.







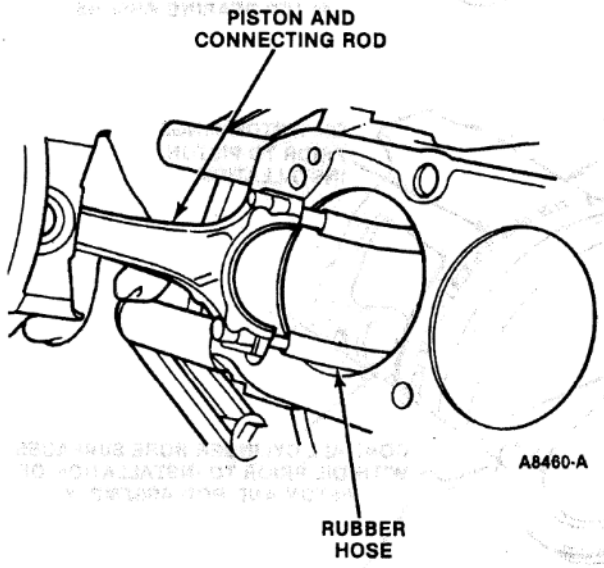
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ENGINE COMPONENT ASSEMBLY

BASE PROCEDURE 29—ASSEMBLY

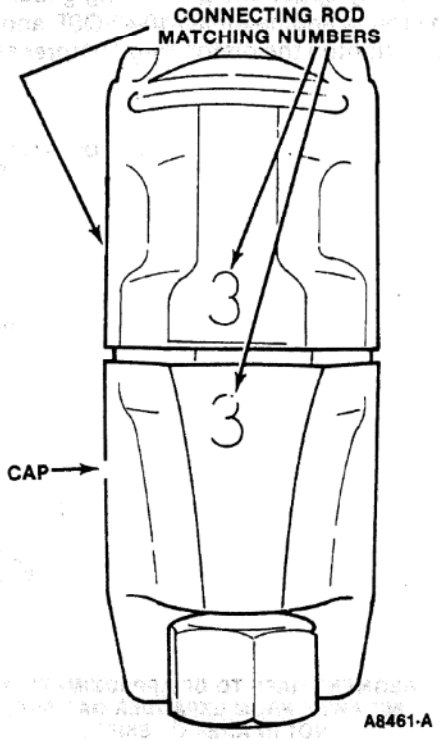
CONNECTING ROD AND PISTON INSTALLATION (Continued)

3. Slip two pieces of snug-fitting rubber hose over the connecting rod bolts to prevent bolt-to-crankshaft journal contact during installation.



4. Start the connecting rod/piston assembly into the cylinder bore, keeping the notch or arrow in the piston top toward the front of the engine. Be sure the connecting rod number and cylinder bore numbers match. Cylinder numbering starts at the front of the engine.

5. Using a hammer handle or piece of wood, tap the piston/rod assembly into the cylinder bore. Guide the rod bolts over the crankshaft journal. Remove the rubber hose from the bolts.
6. Insert the proper size bearing half into the connecting rod cap. Install the cap, making sure that the number on the cap and rod are on the same side and that they match.



7. Install the rod nuts and torque evenly in two steps. During the first step, tighten to 34 to 41 N·m (25 to 30 lb-ft); during the final step, torque to 41 to 49 N·m (30 to 36 lb-ft). Repeat steps 1 through 7 as necessary on the remainder of the rod/piston assemblies.

Then complete:

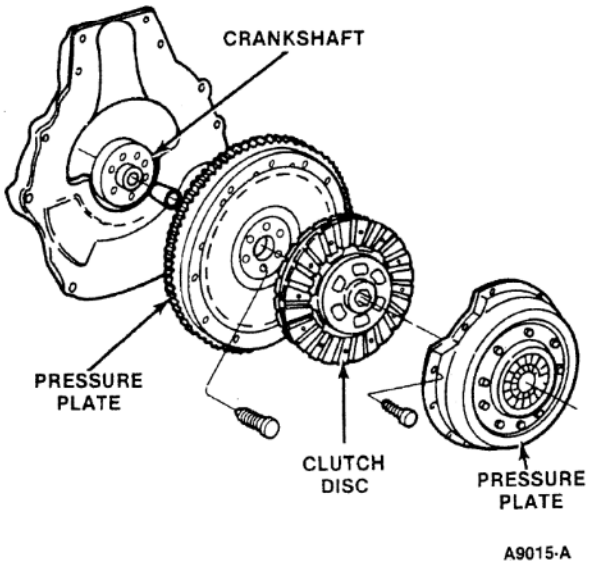
- Base Procedure 26—Assembly, Oil Pan Installation
- Base Procedure 23—Assembly, Cylinder Head Installation

ENGINE COMPONENT ASSEMBLY

BASE PROCEDURE 28—ASSEMBLY

FLYWHEEL OR DRIVE PLATE INSTALLATION

1. Install the flywheel onto the crankshaft.



2. Install the crankshaft-to-flywheel bolts.
3. Torque the bolts to 73 to 87 N·m (56 to 64 lb-ft).

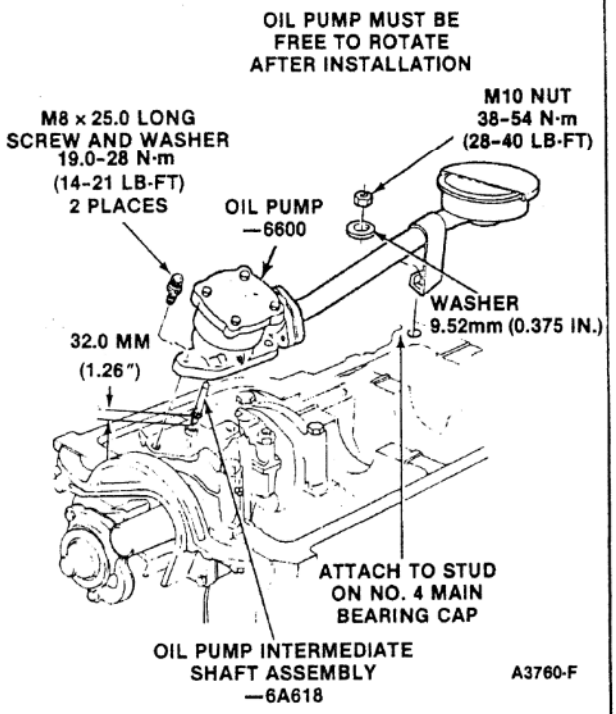
Then complete:

- Install the clutch friction and pressure plate if so equipped. Refer to Section 16-02.
- Install the engine or transmission into the vehicle. If equipped with a manual transmission, refer to Section 16-33. If equipped with an automatic transmission, refer to Section 17-03.

BASE PROCEDURE 27—ASSEMBLY

OIL PUMP INSTALLATION

1. Install the oil pump drive shaft and retaining clip into the cylinder block guide hole or into the oil pump.



2. Install the pump onto the cylinder block. Be sure the pump drive shaft stops in position.
3. Position the oil pump inlet tube bracket over the No. 4 main bearing cap stud.
4. Install the oil pump-to-cylinder block bolts and torque to 19 to 28 N·m (14 to 21 lb-ft).
5. Install the inlet tube bracket to main bearing stud washer and nut. Torque to 38 to 54 N·m (28 to 40 lb-ft).

Then complete:

- Base Procedure 26—Assembly, Oil Pan Installation

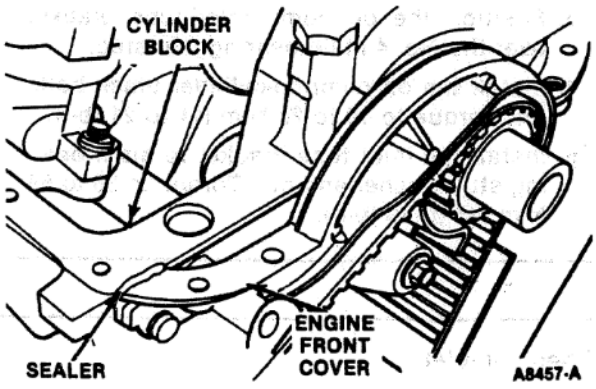
ENGINE COMPONENT ASSEMBLY

BASE PROCEDURE 26—ASSEMBLY

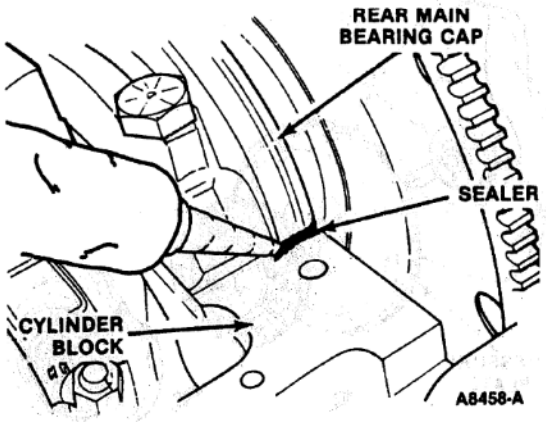
OIL PAN INSTALLATION

1. Clean the gasket surfaces on the oil pan and cylinder block.
2. Apply an even coat of D7AZ-19B508-A, or equivalent, to the oil pan side gaskets.

   Allow the adhesive to dry past the wet stage and install on the oil pan.
3. Apply a 1/4-inch bead of sealer D6AZ-19562-A or -B, or equivalent, along the seam between the cylinder block and the front cover.



4. Apply a 1/4-inch bead of sealer D6AZ-19562-A or -B, or equivalent, along the seam between the cylinder block and the rear main bearing cap.

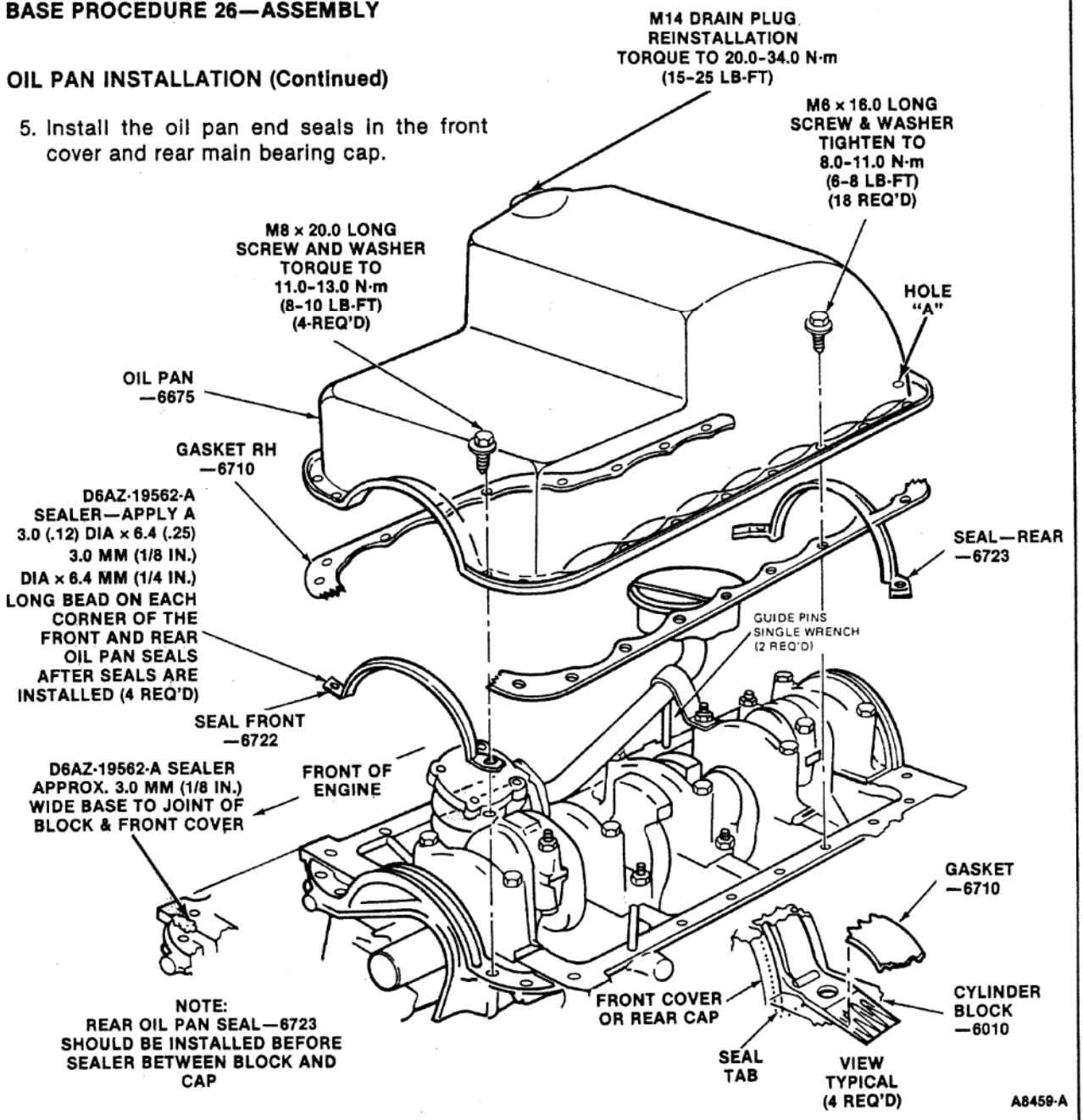


ENGINE COMPONENT ASSEMBLY

BASE PROCEDURE 26—ASSEMBLY

OIL PAN INSTALLATION (Continued)

5. Install the oil pan end seals in the front cover and rear main bearing cap.



6. Position the oil pan and install the attaching bolts.

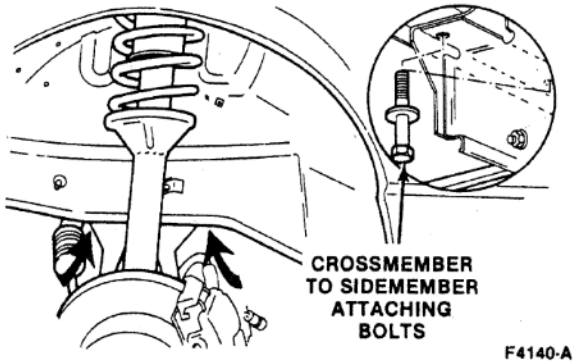
Tighten the corner (M-8) attaching bolts to 11 to 13 N·m (106 to 133 lb-in.) and the smaller (M-6) bolts to 8 to 11 N·m (80 to 102 lb-in.) beginning at hole "A" and working clockwise around the pan.

ENGINE COMPONENT ASSEMBLY

BASE PROCEDURE 26—ASSEMBLY

OIL PAN INSTALLATION (Continued)

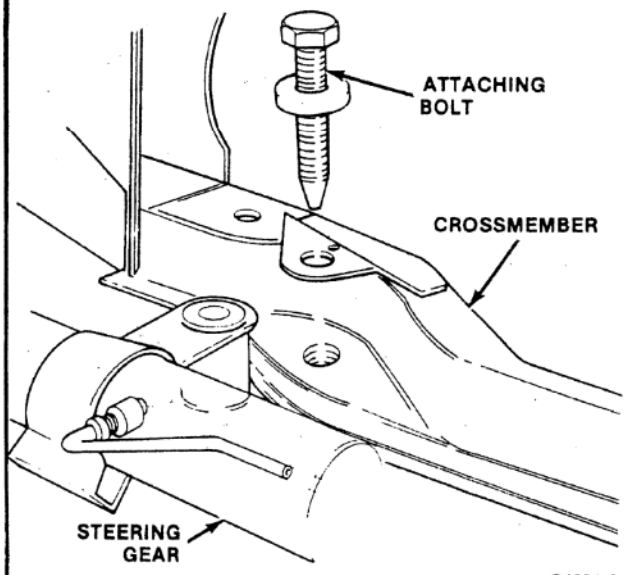
7. Raise the crossmember into position and install the crossmember-to-side member attaching bolts.

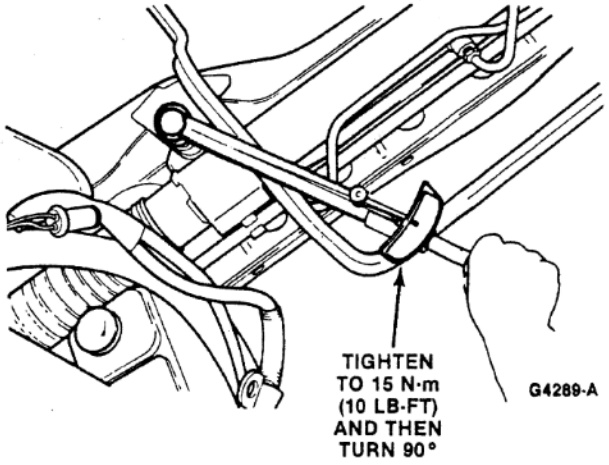


Tighten the attaching bolts to 56 to 64 N·m (38 to 47 lb-ft) and remove the transmission jack.

8. Position the steering gear on the crossmember and connect to the steering column. Refer to Section 13-46.

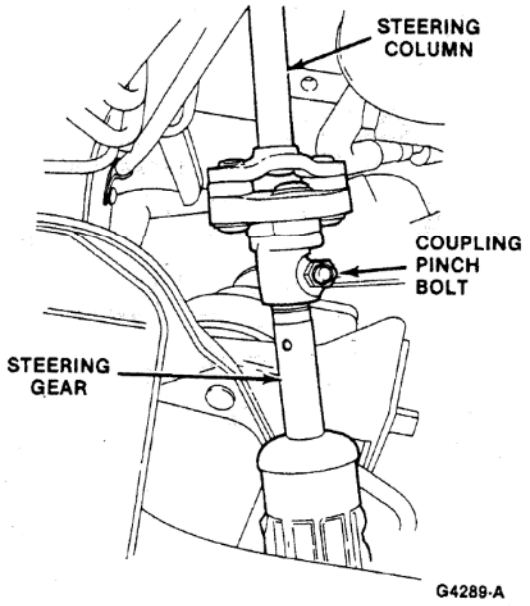
9. Install the steering gear attaching bolts and tighten to 15 N·m (10 lb-ft). After tightening, turn the bolts an additional 90°.



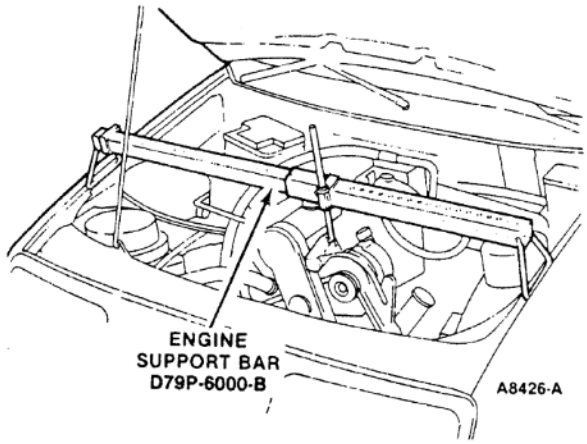


ENGINE COMPONENT ASSEMBLY (Continued)

10. Tighten the steering column-to-gear pinch bolt to 16 to 20 N·m (12 to 15 lb-ft).

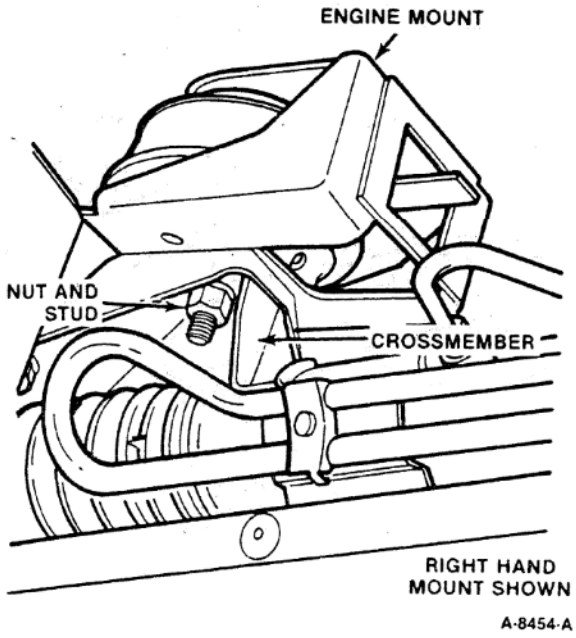


11. Lower the vehicle.
12. Remove the engine support fixture and raise the vehicle.

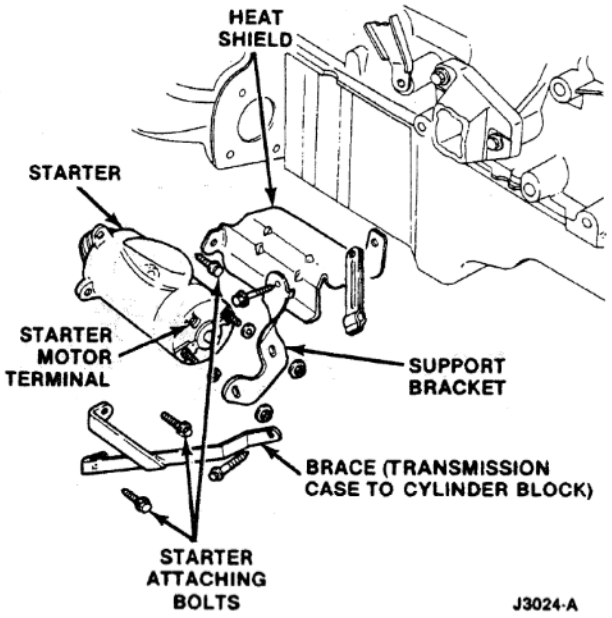


13. Install the engine mount attaching nuts.

    Tighten the attaching nuts to 68 to 95 N·m (50 to 70 lb-ft).



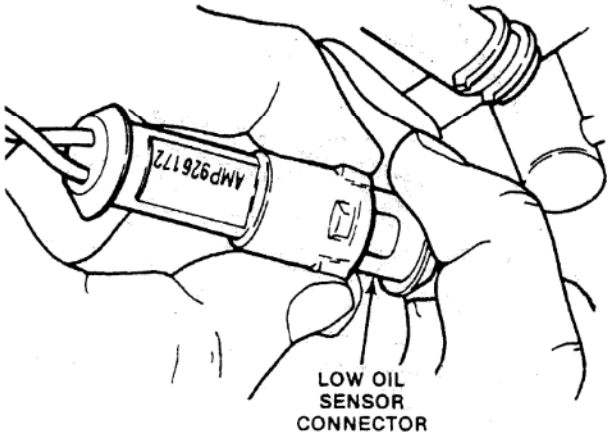
14. Install the starter. If necessary, refer to Section 28-02.

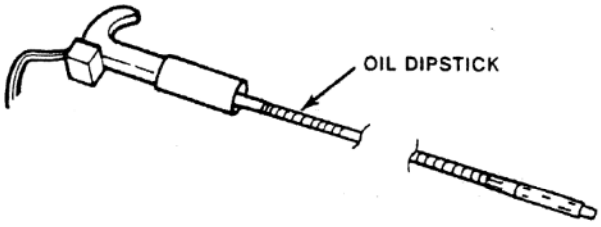


ENGINE COMPONENT ASSEMBLY (Continued)

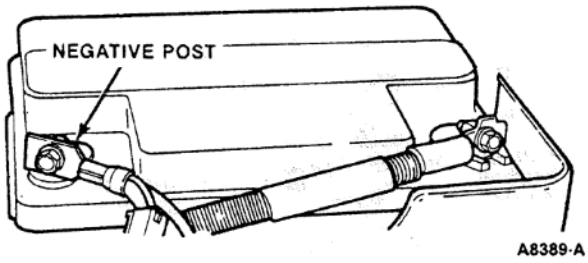
15. Lower the vehicle.
16. Fill the crankcase to the correct level with the specified engine oil.
17. Connect the oil level sensor wiring.

    NOTE: Electrical connector at oil dipstick applies to all units built prior to 3-9-87.





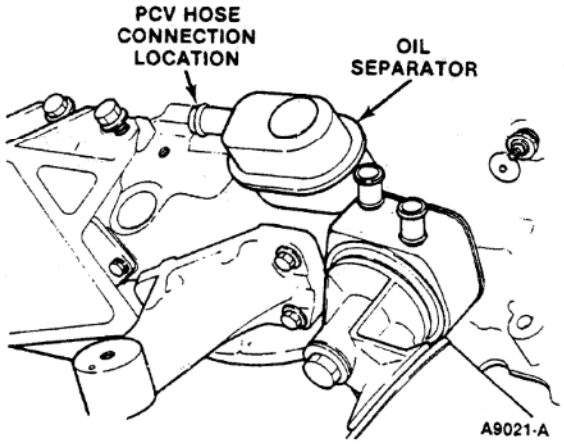
18. Connect the battery cable.



19. Start the engine and check for oil leaks along the edge of the oil pan.

Base Procedure 25—Assembly Oil Separator Installation.

1. Check the oil separator for cleanliness.
2. Position and install the oil separator. Press it into the cylinder block until it is bottomed in its hole.



3. Connect the PCV hose to the nipple on the front of the separator.

Then complete:

- Base Procedure 21—Assembly, Fuel Charging Assembly Installation

ENGINE COMPONENT ASSEMBLY (Continued)

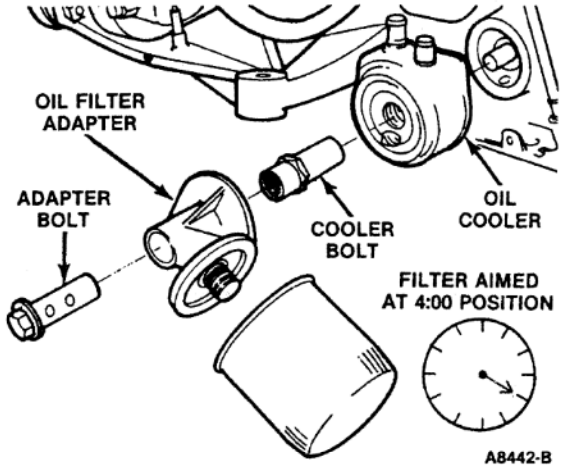
Base Procedure 24—Assembly

Oil Filter and Cooler Installation

SPECIAL SERVICE TOOL REQUIRED:

Oil Filter Wrench D79L-6731-B

1. Be sure all parts are clean. Coat all gasket surfaces with engine oil.
2. If necessary, install a 3/4-in. pipe nipple into the cylinder block and torque to 28 to 35 N·m (20 to 25 lb-ft).
3. Install the gasket and the oil cooler. Start the oil cooler insert bolt. Torque the insert bolt to 54 to 68 N·m (40 to 50 lb-ft).

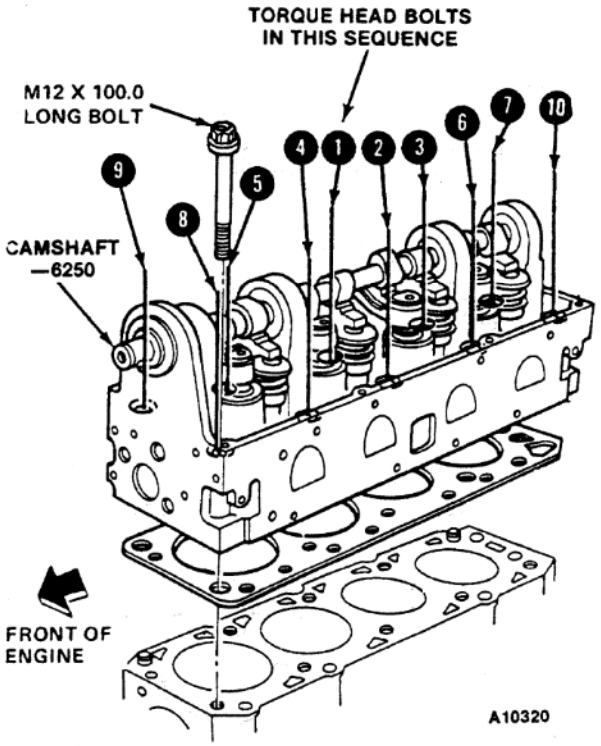


4. Install the oil filter adapter gasket and the adapter. Start the adapter bolt. Torque the bolt to 54 to 68 N·m (40 to 50 lb-ft). The oil filter adapter plate must be installed to the oil cooler with the filter aimed toward the 4 o'clock position. Failure to install the oil filter adapter plate at this specified angle can result in the oil filter contacting the rear engine boss, which could puncture the filter.
5. Install the new oil filter by hand until the filter gasket contacts the filter adapter. Turn the filter an additional one-half turn, using D79L-6731-B, or equivalent, if necessary. An optional method is to torque the filter to 10 to 14 N·m (95 to 125 lb-in.).
6. Install the oil cooler coolant hoses onto the oil cooler.
7. Check engine oil level and add XO-10-40-QSO oil to the full level on the dipstick. The system holds 4.75 liters or 5 quarts including the filter.
8. Fill the cooling system.

Base Procedure 23—Assembly

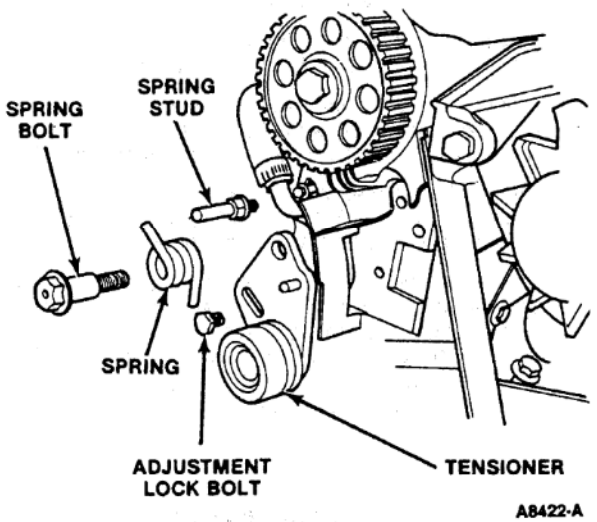
Cylinder Head Installation

1. Be sure the cylinder head and cylinder block gasket surfaces are clean.
2. Position a new cylinder head gasket on the block. It is marked "Front-Up" on one side.
3. Lower the cylinder head assembly onto the cylinder block. Be sure the head fits over the two dowels on the head surface of the block.
4. Install the rocker arm cover gasket onto the cover using D7AZ-19B508-A contact cement, or equivalent, and set the cover aside.
5. Oil the cylinder head bolts and install them in the cylinder head. Torque them in two steps. During the first step, tighten to 68 to 81 N·m (50 to 60 lb-ft); during the final step, tighten to 108 to 122 N·m (80 to 90 lb-ft). Be sure to torque them in the proper sequence.

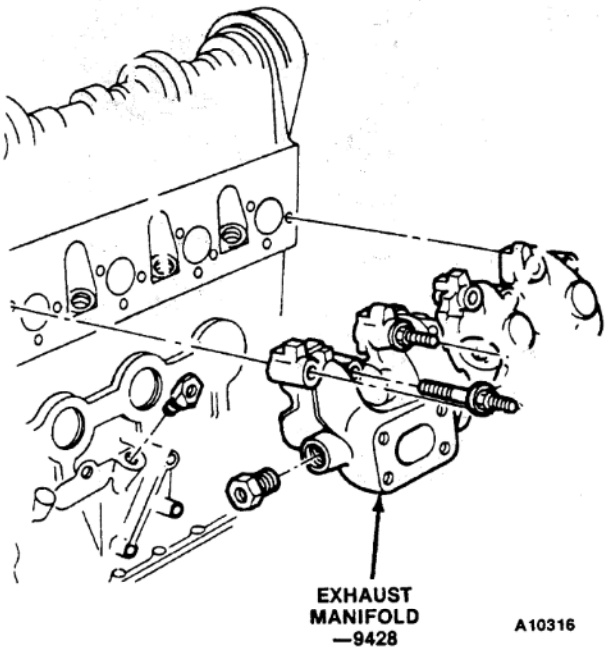


ENGINE COMPONENT ASSEMBLY (Continued)

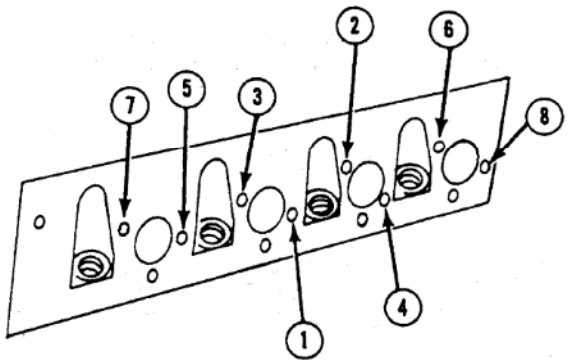
6. Install the timing belt tensioner spring stop stud into the cylinder head. Torque it to 19 to 29 N·m (14 to 21 lb-ft).



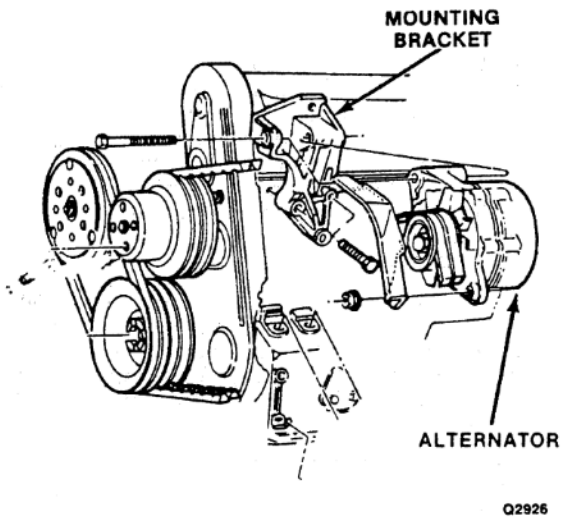
7. Position the exhaust manifold on the cylinder head and install the attaching bolts.



8. Torque them in two steps. During the first step, tighten to 7 to 9 N·m (5 to 7 lb-ft); during the final step, tighten to 23 to 31 N·m (16 to 23 lb-ft). Be sure to follow the proper torque sequence.



9. Install the alternator bracket-to-cylinder head bolts.



ENGINE COMPONENT ASSEMBLY

BASE PROCEDURE 23—ASSEMBLY

CYLINDER HEAD INSTALLATION (Continued)

Then complete:

- Base Procedure 21—Assembly, Fuel Supply Manifold Installation
- Base Procedure 18—Assembly, Timing Belt Inner Cover Installation
- Base Procedure 16—Assembly, Auxiliary Sprocket Installation
- Base Procedure 15—Assembly, Timing Belt Tensioner Installation
- Base Procedure 13—Assembly, Camshaft Sprocket or Seal Installation
- Base Procedure 12—Assembly, Timing Belt Installation
- Base Procedure 14—Assembly, Crankshaft Damper and Pulley Installation
- Base Procedure 7—Assembly, Timing Belt Cover Installation
- Base Procedure 6—Assembly, Water Pump Pulley Installation
- Base Procedure 5—Assembly, Drive Belts Installation
- Base Procedure 9—Assembly, Rocker Arm Cover Installation

BASE PROCEDURE 22—ASSEMBLY

LOWER INTAKE MANIFOLD INSTALLATION

Refer to Section 24-29 for a complete description of Lower Intake Manifold removal and installation.

BASE PROCEDURE 21—ASSEMBLY

FUEL SUPPLY MANIFOLD INSTALLATION

Refer to Section 24-29 for a complete description of the fuel supply manifold removal and installation procedure.

BASE PROCEDURE 20—ASSEMBLY
UPPER INTAKE MANIFOLD INSTALLATION

Refer to Section 24-29 for a complete description of upper intake manifold removal and installation procedure.

BASE PROCEDURE 19—ASSEMBLY

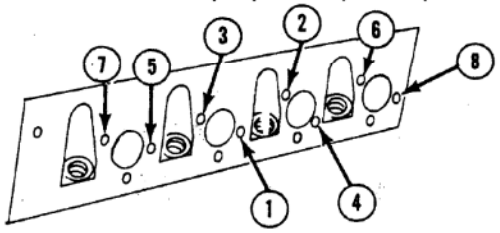
EXHAUST MANIFOLD INSTALLATION

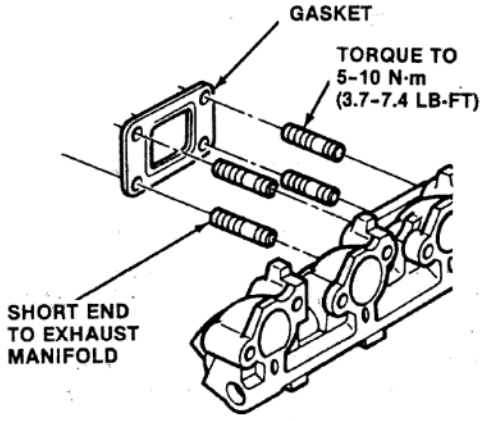
1. Be sure the exhaust manifold and the manifold surfaces on the cylinder head are clean.

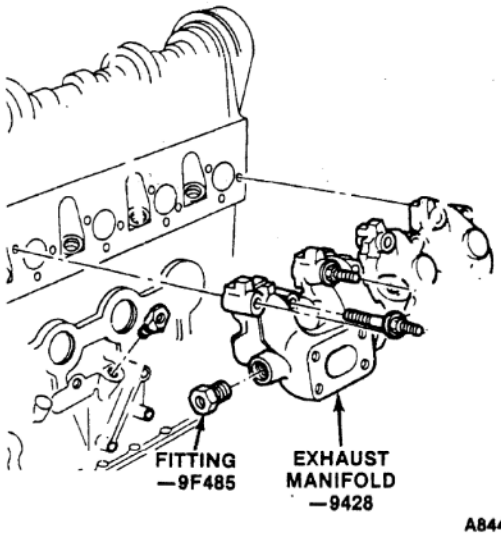
ENGINE COMPONENT ASSEMBLY

BASE PROCEDURE 19—ASSEMBLY EXHAUST MANIFOLD INSTALLATION (Continued)

2. Install the exhaust manifold-to-cylinder head bolts. Torque them in two steps. During the first step, tighten to 20 to 23 N·m (177 to 204 lb-in.); during the final step, tighten to 27 to 41 N·m (20 to 30 lb-ft). Be sure to follow the proper torque sequence.

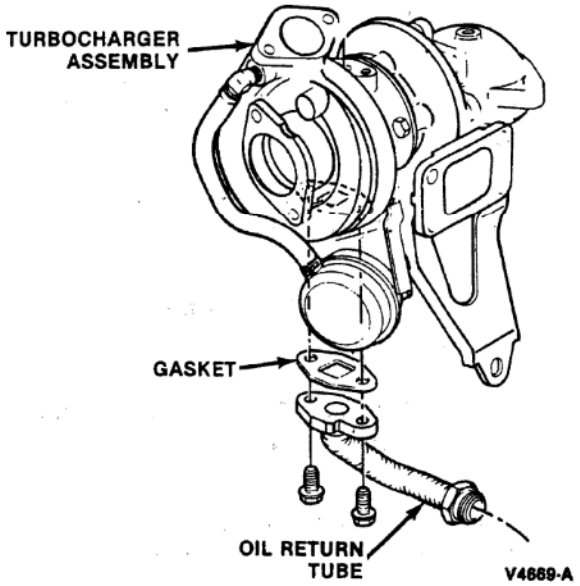




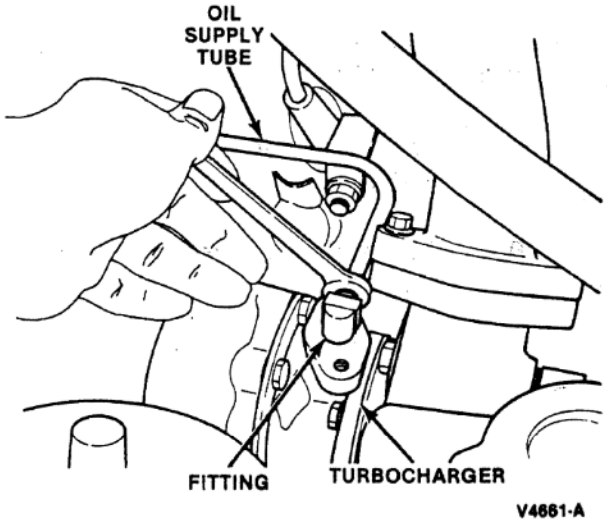


3. Install the turbocharger support bracket.

4. Install the turbo-to-exhaust manifold nuts.



5. Connect the PCV tube at the turbo air inlet adapter.
6. Connect the turbo coolant supply tube at the turbocharger.
7. Connect the turbo oil supply line at the turbocharger.

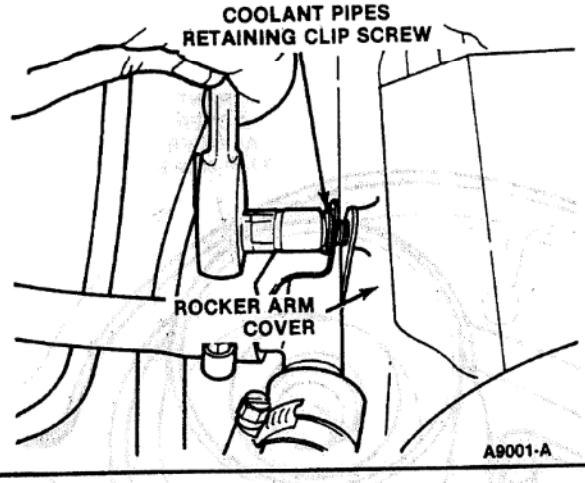


ENGINE COMPONENT ASSEMBLY

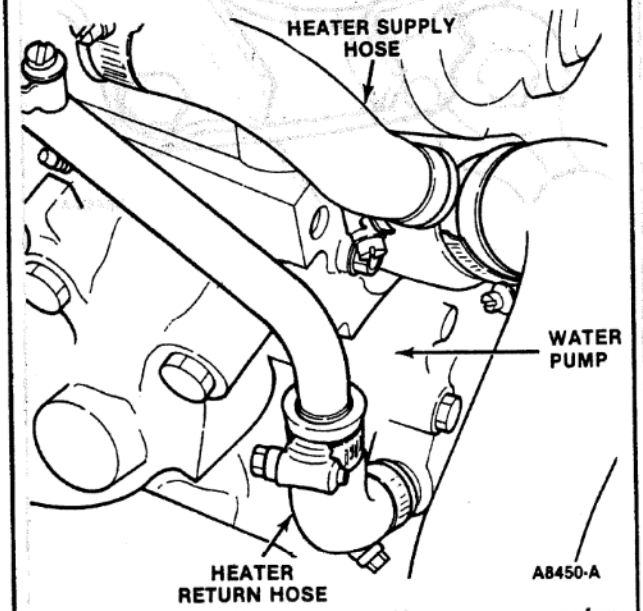
BASE PROCEDURE 19—ASSEMBLY

EXHAUST MANIFOLD INSTALLATION (Continued)

8. Install the heater pipe-to-coolant expansion tank hose at the heater pipe.
9. Install the coolant pipe retaining clip screw at the rocker arm cover.



10. Install the coolant return hose at the water pump.

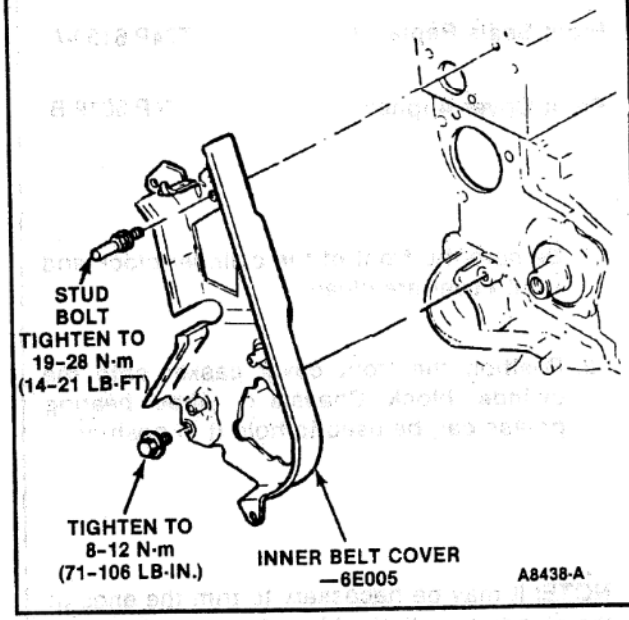


11. Fill the cooling system. If necessary, refer to Section 27-03.

BASE PROCEDURE 18—ASSEMBLY

TIMING BELT INNER COVER INSTALLATION

1. Install the timing belt inner cover, stud bolt and retaining bolts. Torque the stud bolt to 19 to 28 N·m (14 to 21 lb-ft) and the retaining bolts to 8 to 12 N·m (71 to 106 lb-in.).



Then complete:

- Base Procedure 15—Assembly, Timing Belt Tensioner Installation
- Base Procedure 13—Assembly, Camshaft Sprocket Installation
- Base Procedure 16—Assembly, Auxiliary Sprocket Installation
- Base Procedure 12—Assembly, Timing Belt Installation
- Base Procedure 14—Assembly, Crankshaft Damper and Pulley Installation
- Base Procedure 7—Assembly, Timing Belt Cover Installation
- Base Procedure 6—Assembly, Water Pump Pulley Installation
- Base Procedure 5—Assembly, Drive Belts Installation

ENGINE COMPONENT ASSEMBLY

BASE PROCEDURE 17—ASSEMBLY

CRANKSHAFT SPROCKET, FRONT COVER SEAL, AND COVER INSTALLATION

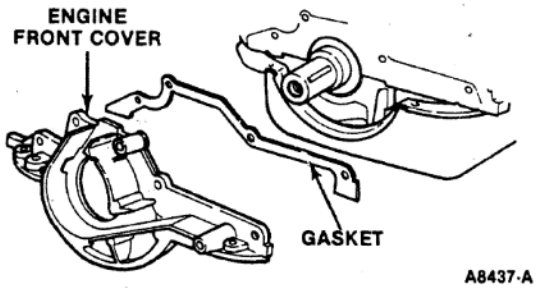
SPECIAL SERVICE TOOLS REQUIRED:

Front Seals Replacer	T74P-6150-A
Front Cover Aligner	T74P-6019-B

1. Be sure the front of the cylinder block and front cover are clean.
2. Position the front cover gasket onto the cylinder block. Chassis or wheel bearing grease can be used to hold it in position.

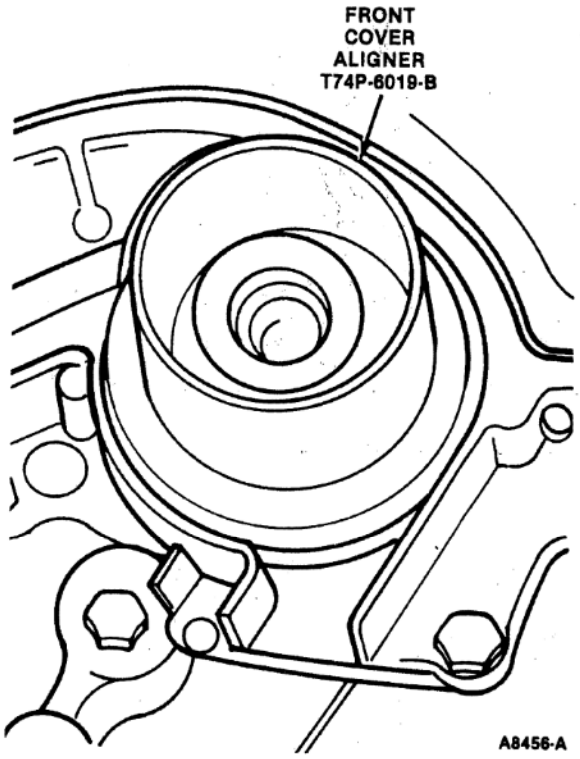
NOTE: It may be necessary to trim the ends of the oil pan to cylinder block front seal if installing a cover without replacing the oil pan gasket.

3. Install the front cover without the seal in it. Start the bolts but leave them loose.



A8437-A

4. Insert engine Front Cover Aligner T74P-6019-B, or equivalent, into the cover to align it with the crankshaft. Torque the bolts to 8 to 12 N·m (6 to 9 lb-ft). Remove the alignment tool.



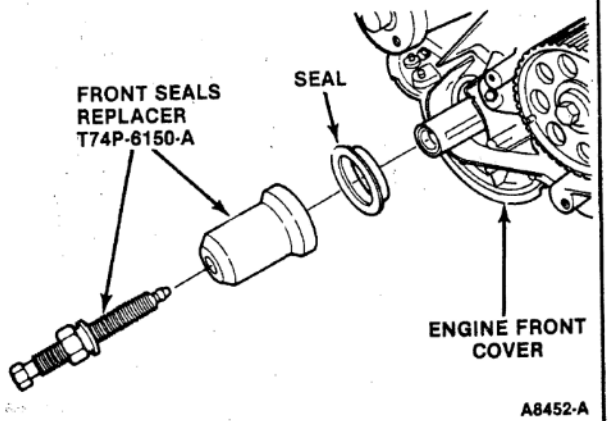
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ENGINE COMPONENT ASSEMBLY

BASE PROCEDURE 17—ASSEMBLY

CRANKSHAFT SPROCKET, FRONT COVER SEAL, AND COVER INSTALLATION (Continued)

5. Oil the inner lip of the cover seal and install it using Front Seals Replacer T74P-6150-A, or equivalent.
6. Thread the tool and seal onto the crankshaft. With the outer nut, force the tool and seal toward the engine until the seal bottoms in the front cover. Remove the tool.



7. Install the crankshaft sprocket. It should slip onto the crankshaft and is retained by the crankshaft pulley.

Then complete:

- Base Procedure 12—Assembly, Timing Belt Installation
- Base Procedure 14—Assembly, Crankshaft Damper and Pulley Installation
- Base Procedure 7—Assembly, Timing Belt Cover Installation
- Base Procedure 6—Assembly, Water Pump Pulley Installation
- Base Procedure 5—Assembly, Drive Belts Installation

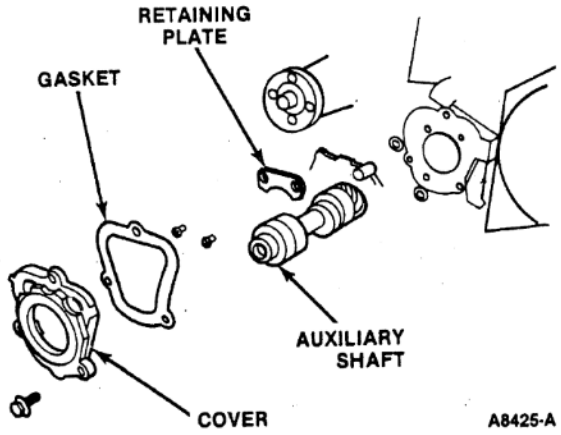
BASE PROCEDURE 16—ASSEMBLY

AUXILIARY SHAFT SPROCKET OR SEAL INSTALLATION

SPECIAL SERVICE TOOLS REQUIRED:

Front Seals Replacer	T74P-6150-A
Cam Sprocket Holding/Removing Tool	T74P-6256-B

1. Be sure the auxiliary shaft and bearings are clean and not worn or damaged.
2. Dip the auxiliary shaft in engine oil.
3. Carefully install the auxiliary shaft in the bearing bores. Do not scratch the bearings.
4. Install the auxiliary shaft retaining plate.



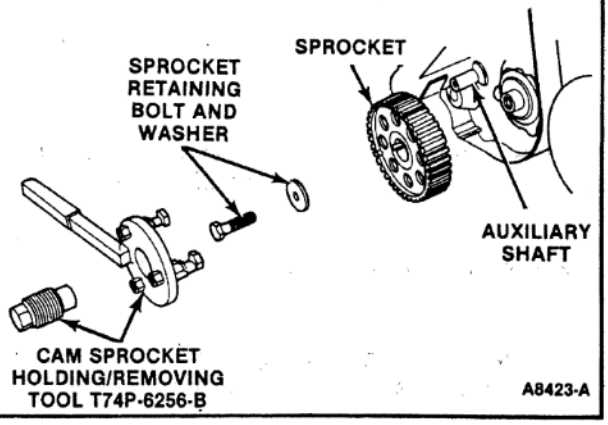
5. Install the auxiliary shaft gasket and cover without the seal. Torque the bolts to 8 to 12 N·m (71 to 106 lb-ft).

ENGINE COMPONENT ASSEMBLY

BASE PROCEDURE 16—ASSEMBLY

AUXILIARY SHAFT SPROCKET OR SEAL INSTALLATION (Continued)

6. Install the auxiliary shaft seal using Front Seals Replacer T74P-6150-A, or equivalent.
7. Install the auxiliary shaft sprocket using Cam Sprocket Holding/Removing Tool T74P-6256-B, or equivalent. Remove the center arbor. The tool is used as a holding fixture. The sprocket retaining bolt presses the sprocket on the shaft. Torque the bolt to 38 to 54 N·m (28 to 40 lb-ft).



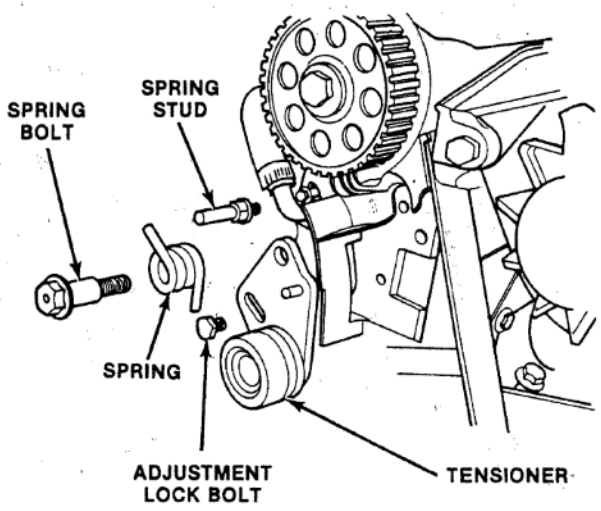
Then complete:

- Base Procedure 12—Assembly, Timing Belt Installation
- Base Procedure 14—Assembly, Crankshaft Damper and Pulley Installation
- Base Procedure 7—Assembly, Timing Belt Cover Installation
- Base Procedure 6—Assembly, Water Pump Pulley Installation
- Base Procedure 5—Assembly, Drive Belts Installation

BASE PROCEDURE 15—ASSEMBLY

TIMING BELT TENSIONER INSTALLATION

1. Be sure the timing belt tensioner and the timing sprockets are clean and not worn.
2. Place the timing belt tensioner and spring in position.
3. Install the timing belt tensioner, spring, pivot bolt, and adjustment bolt finger tight.



Then complete:

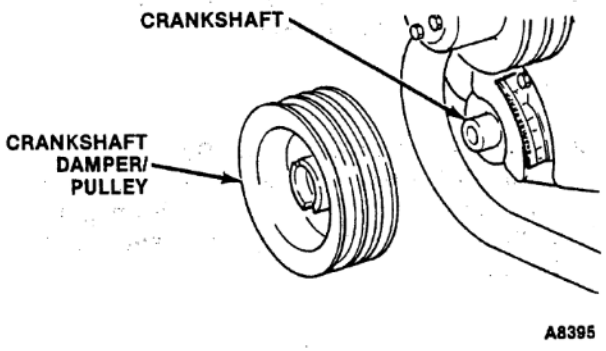
- Base Procedure 12—Assembly, Timing Belt Installation
- Base Procedure 7—Assembly, Timing Belt Cover Installation
- Base Procedure 14—Assembly, Crankshaft Damper and Pulley Installation
- Base Procedure 6—Assembly, Water Pump Pulley Installation
- Base Procedure 5—Assembly, Drive Belts Installation

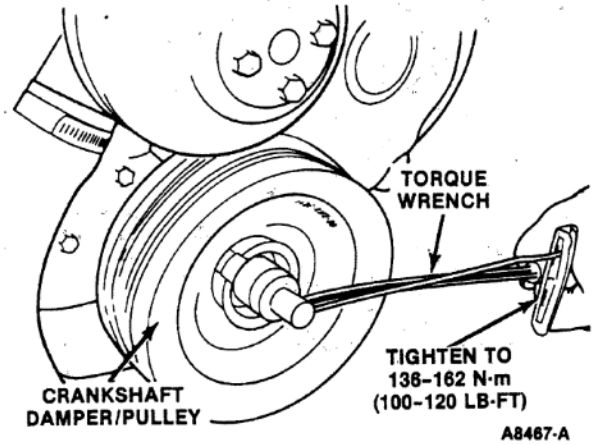
ENGINE COMPONENT ASSEMBLY

BASE PROCEDURE 14—ASSEMBLY

CRANKSHAFT DAMPER AND PULLEY INSTALLATION

1. Be sure the crankshaft damper and pulley are clean and not damaged.
2. Install the damper and pulley onto the crankshaft. Start the retaining bolt.
3. Torque the bolt to 136 to 162 N·m (100 to 120 lb-ft).





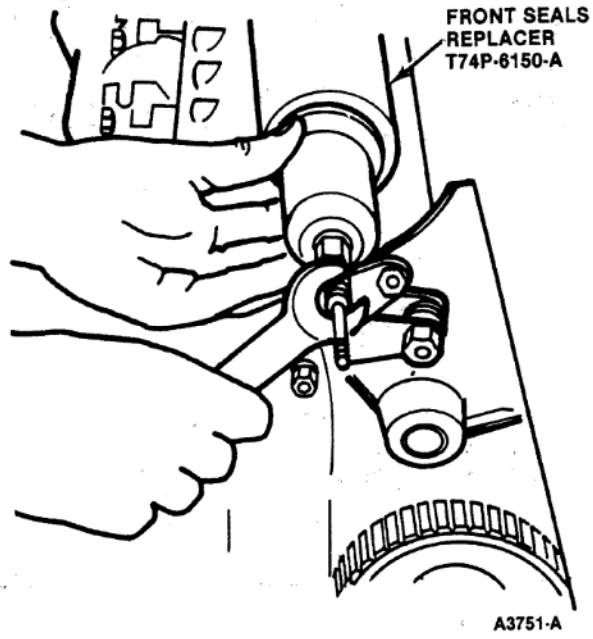
BASE PROCEDURE 13—ASSEMBLY

CAMSHAFT SPROCKET OR SEAL INSTALLATION

SPECIAL SERVICE TOOLS REQUIRED:

Cam Sprocket Holding/Removing Tool	T74P-6256-B
Front Seals Replacer	T74P-6150-A

1. Be sure the seal and seal surface on the camshaft are clean and not damaged.
2. Lubricate the camshaft seal surface and the seal lip with engine oil.
3. Install the seal onto Front Seals Replacer T74P-6150-A, or equivalent.



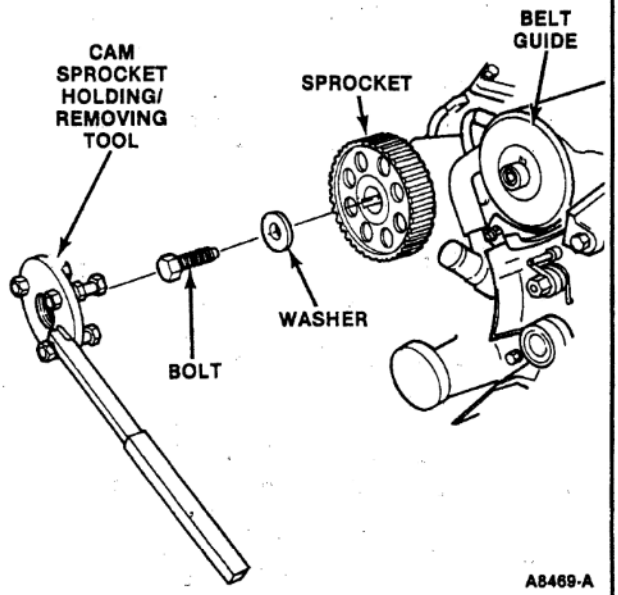
4. Thread the tool arbor into the camshaft.
5. Turn the nut on the tool arbor until the seal is bottomed in its bore in the camshaft front bearing tower.
6. Remove the tool from the camshaft.

ENGINE COMPONENT ASSEMBLY

BASE PROCEDURE 13—ASSEMBLY

CAMSHAFT SPROCKET OR SEAL INSTALLATION (Continued)

7. Install the camshaft sprocket belt guide.
8. Install the camshaft sprocket using Cam Sprocket Holding/Removing Tool T74P-6256-B, or equivalent, as a holding fixture and the sprocket retaining bolt to push the sprocket onto the camshaft.



Use a new camshaft sprocket bolt or Teflon tape when installing. Torque the sprocket bolt to 68 to 96 N·m (50 to 71 lb-ft).

Then complete:

- Base Procedure 12—Assembly, Timing Belt Installation
- Base Procedure 7—Assembly, Timing Belt Cover Installation
- Base Procedure 14—Assembly, Crankshaft Damper Installation
- Base Procedure 6—Assembly, Water Pump Pulley Installation
- Base Procedure 5—Assembly, Drive Belts Installation

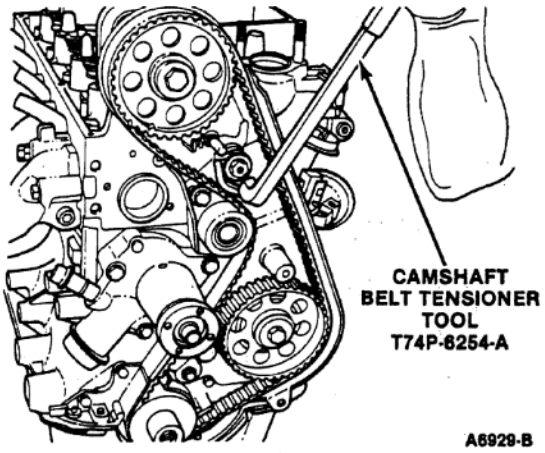
BASE PROCEDURE 12—ASSEMBLY

TIMING BELT INSTALLATION

SPECIAL SERVICE TOOL REQUIRED:

Camshaft Belt Tensioner Tool	T74P-6254-A

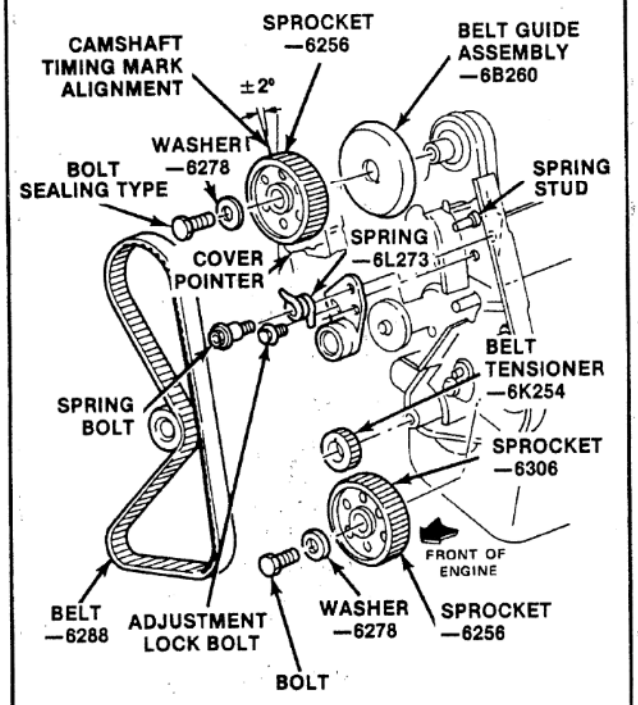
1. Be sure the belt and sprockets are clean and not worn or damaged.
2. With the aid of Camshaft Belt Tensioner Tool T74P-6254-A, or equivalent, move the belt tensioner to the no tension position, tighten the adjustment lock bolt and install the belt.



ENGINE COMPONENT DISASSEMBLY

BASE PROCEDURE 12—ASSEMBLY

TIMING BELT INSTALLATION (Continued)



3. Loosen the adjustment lock bolt and allow the tensioner to tighten the belt.
4. Torque the pivot bolt (in the spring) to 38 to 54 N·m (28 to 40 lb-ft) and the adjustment lock bolt to 19 to 28 N·m (14 to 21 lb-ft).

Then complete:

- Base Procedure 14—Assembly, Crankshaft Damper and Pulley Installation
- Base Procedure 7—Assembly, Timing Belt Cover Installation
- Base Procedure 6—Assembly, Water Pump Pulley Installation
- Base Procedure 5—Assembly, Drive Belts Installation

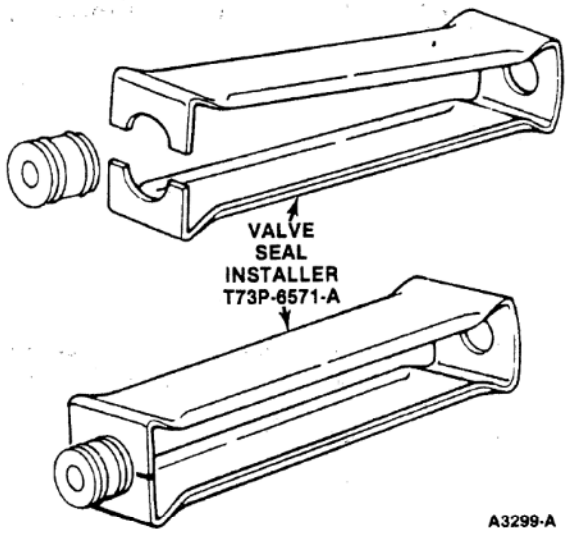
BASE PROCEDURE 11—ASSEMBLY

VALVE SPRINGS AND SEALS INSTALLATION

SPECIAL SERVICE TOOLS REQUIRED:

Valve Seal Installer	T73P-6571-A
Valve Spring Compressor	T74P-6565-A

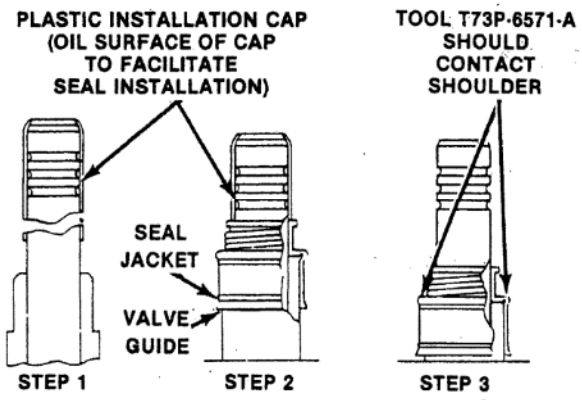
1. Inspect the valve stems for scores, sticking, excess or obvious stem-to-guide clearance and eccentricity or wobbling when rotated. If any of the above conditions exist, the cylinder head must be removed for further inspection and service. If necessary, refer to the procedure in this section.
2. Apply air pressure through the spark plug holes to hold the valves closed. Install new valve stem seals using Valve Seal Installer T73P-6571-A, or equivalent, and the plastic installation caps.



ENGINE COMPONENT ASSEMBLY

BASE PROCEDURE 11—ASSEMBLY

VALVE SPRINGS AND SEALS INSTALLATION (Continued)



STEP #1— WITH VALVES IN HEAD, PLACE PLASTIC INSTALLATION CAP OVER END OF VALVE SYSTEM.

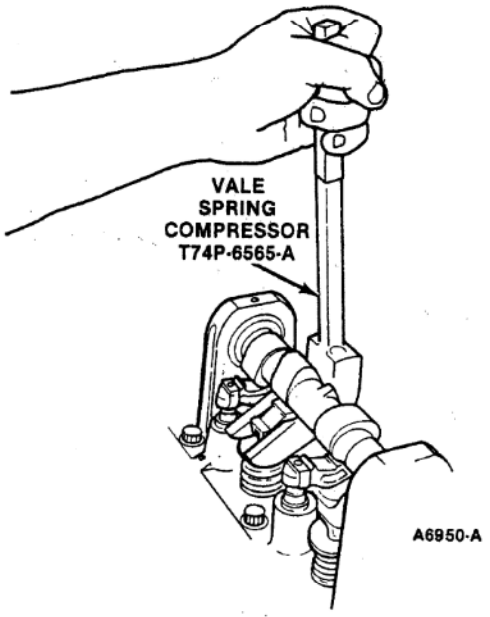
STEP #2— START VALVE STEM SEAL CAREFULLY OVER CAP. PUSH SEAL DOWN UNTIL JACKET TOUCHES TOP OF GUIDE.

STEP #3— REMOVE PLASTIC INSTALLATION CAP. USE INSTALLATION TOOL T73P-6571-A OR SCREWDRIVERS TO BOTTOM SEAL ON VALVE GUIDE.

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3. Install the valve springs, spring retainers and keys using Valve Spring Compressor T74P-6565-A, or equivalent. Remove the air pressure and adapter.

4. Depress the valve springs and install the cam followers.



Then complete:

- Base Procedure 9—Assembly, Rocker Arm Cover Installation
- Install the throttle body. Refer to Section 24-29.

ENGINE COMPONENT ASSEMBLY

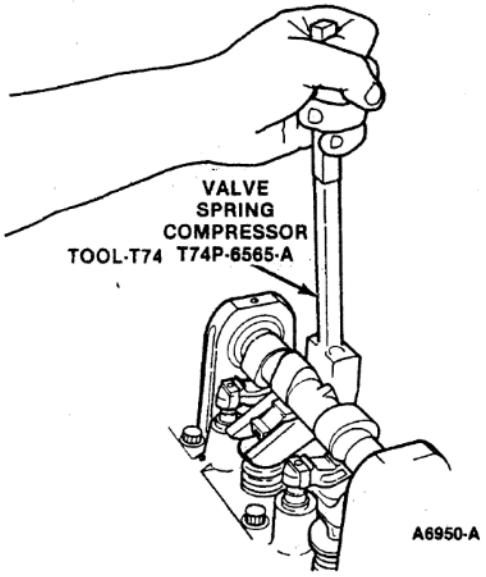
BASE PROCEDURE 10—ASSEMBLY

HYDRAULIC LASH ADJUSTER INSTALLATION

SPECIAL SERVICE TOOL REQUIRED:

Valve Spring Compressor T74P-6565-A

1. If necessary, rotate engine in its normal direction (crankshaft rotates clockwise) until the base circle of the camshaft lobe, of the hydraulic lash adjuster to be installed, is facing the camshaft.
2. Be sure the lash adjuster bore is clean. Install a new or tested hydraulic lash adjuster into its bore in the cylinder head.
3. Using Valve Spring Compressor T74P-6565-A, or equivalent, depress the applicable valve spring until the cam follower can be inserted into position over the lash adjuster. Fully depress the lash adjuster with the tool and release it.



4. Repeat steps 1 through 3 as required.

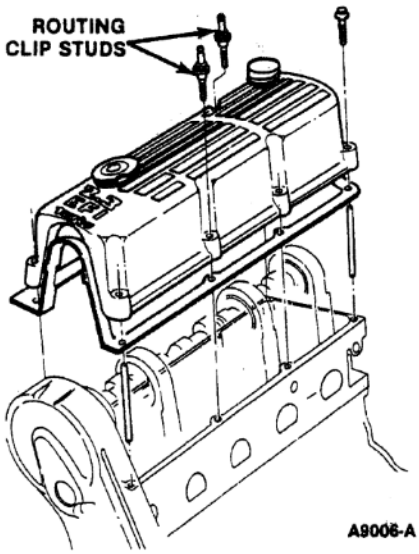
Then complete:

- Base Procedure 9—Assembly, Rocker Arm Cover Installation
- Throttle Body Installation. Refer to Section 24-29.

BASE PROCEDURE 9—ASSEMBLY

ROCKER ARM COVER INSTALLATION

1. If not previously done, clean the rocker arm cover and cement a new gasket to the sealing surface using D7AZ-19B508-A, or equivalent. Allow to dry past the wet stage.
2. Be sure the cylinder head rocker arm cover sealing surface is clean.
3. Place the rocker arm cover onto the cylinder head.
4. Start the retaining studs and bolts.

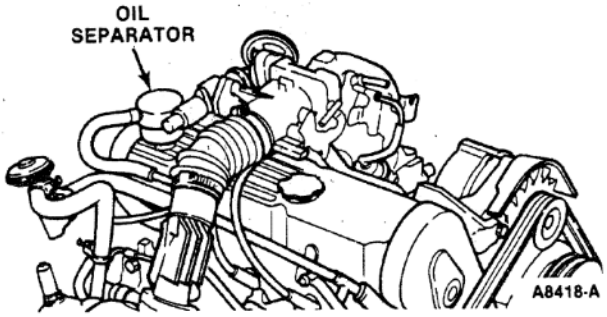


ENGINE COMPONENT ASSEMBLY

BASE PROCEDURE 9—ASSEMBLY

ROCKER ARM COVER INSTALLATION (Continued)

5. Torque the studs and bolts to 7 to 11 N·m (5 to 8 lb-ft).
6. Install the coolant hose supply and return clip screw at the right front side of the rocker arm cover.
7. Install the coolant hose that passes over the rear of the rocker arm cover.
8. Install the PCV hose onto the oil separator on the rocker arm cover.

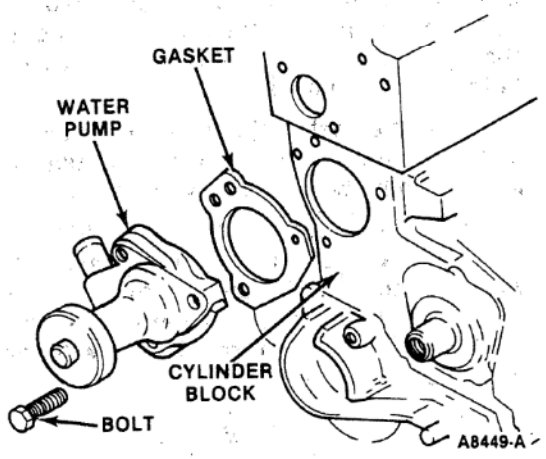


9. Fill the cooling system.

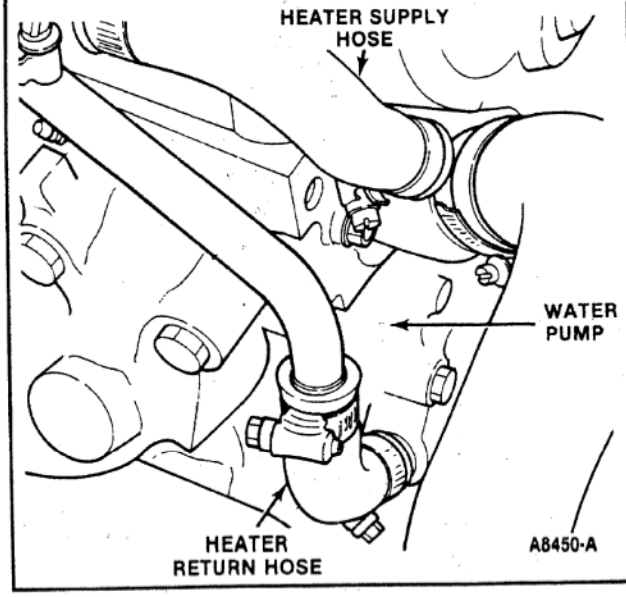
BASE PROCEDURE 8—ASSEMBLY

WATER PUMP INSTALLATION

1. Be sure the water pump gasket surfaces on the water pump and on the cylinder block are clean.
2. Install a new gasket, the water pump bolts, and the water pump onto the cylinder block.



3. Torque the bolts to 19 to 29 N·m (14 to 21 lb-ft).
4. Connect the lower radiator and coolant hoses to the water pump.

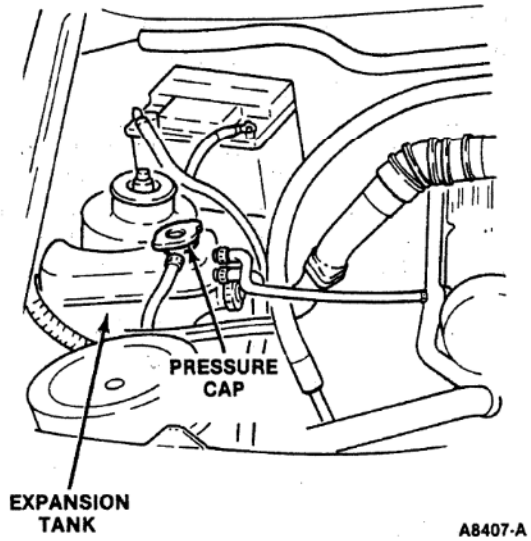


ENGINE COMPONENT ASSEMBLY

BASE PROCEDURE 8—ASSEMBLY

WATER PUMP INSTALLATION (Continued)

5. Fill the cooling system.



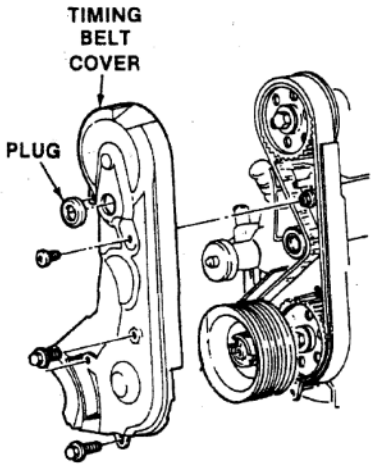
Then complete:

- Base Procedure 7—Assembly, Timing Belt Cover Installation
- Base Procedure 6—Assembly, Water Pump Pulley Installation
- Base Procedure 5—Assembly, Drive Belts Installation

BASE PROCEDURE 7—ASSEMBLY

TIMING BELT COVER INSTALLATION

1. Be sure the cover and its mounting surface on the engine are clean.
2. Install the cover and the four retaining bolts.



3. Torque the bolts to 8 to 12 N·m (71 to 106 lb-in.).

Then complete:

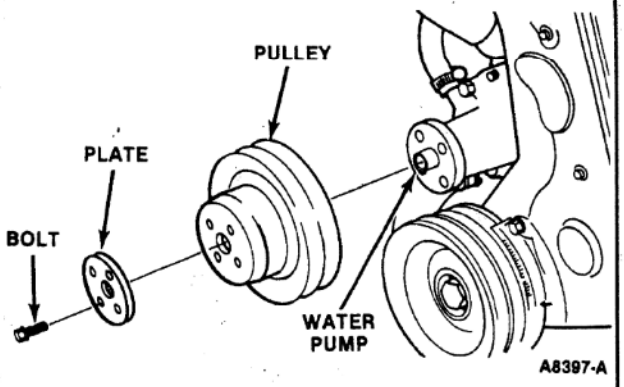
- Base Procedure 6—Assembly, Water Pump Pulley Installation
- Base Procedure 5—Assembly, Drive Belts Installation

ENGINE COMPONENT ASSEMBLY

BASE PROCEDURE 6—ASSEMBLY

WATER PUMP PULLEY INSTALLATION

1. Be sure the pulley and water pump hub are clean and not damaged.
2. Install the pulley and pulley-to-water pump hub bolts.



3. Torque the bolts to 19 to 28 N·m (16 to 21 lb-ft).

Then complete:

- Base Procedure 5—Assembly, Drive Belts Installation

BASE PROCEDURE 5—ASSEMBLY

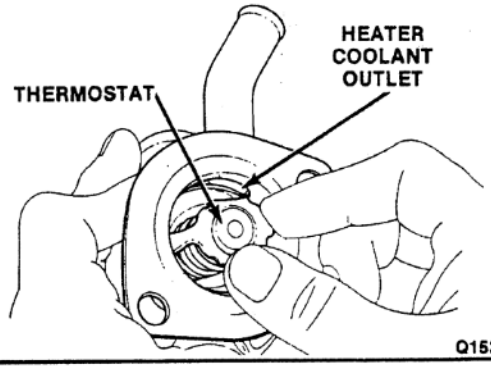
DRIVE BELTS INSTALLATION

1. Be sure the drive belts are clean and not worn or damaged.
2. For drive belts installation and final adjustment, refer to Section 27-02.

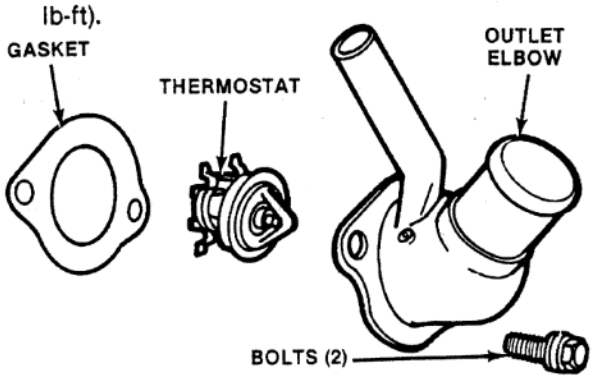
BASE PROCEDURE 4—ASSEMBLY

COOLANT OUTLET ELBOW OR THERMOSTAT INSTALLATION

1. Clean the coolant outlet and the cylinder head at the gasket surface.
2. Coat a new gasket with B5A-19554-A sealer, or equivalent. Place the gasket in position on the cylinder head.
3. Install a new or tested thermostat into the coolant outlet elbow recess with the bridge end of the thermostat into the elbow. Turn the thermostat left or right until it locks in the elbow. Be sure the heater coolant outlet hole is open and visible.



4. Place the elbow/thermostat onto the gasket and cylinder head and install the bolts. Torque the bolts to 19 to 28 N·m (14 to 21 lb-ft).



5. Install the heater coolant hose and the upper radiator hose onto the coolant outlet elbow.
6. Fill the cooling system. If necessary, refer to Section 27-03. Run the engine and check for leaks.

CLEANING, INSPECTION, AND OVERHAUL

The following procedures apply to a base 2.3L engine that has been disassembled to its major components. The components are:

- Cylinder block
- Crankshaft
- Connecting rod and piston assemblies
- Cylinder head assembly
- Oil pump

The procedures for removing or separating various engine components are located in the Engine Disassembly section. Locate the sections on the Contents page under Base Procedures.

Operations described under Cleaning, Inspection, and Overhaul are procedures that can be performed in a satisfactorily equipped dealership or service facility by a qualified technician.

CYLINDER BLOCK

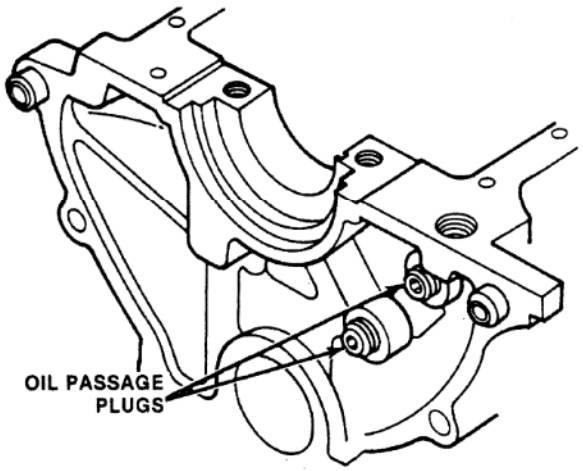
SPECIAL SERVICE TOOLS REQUIRED:

Puller Attachment Tool	T58L-101-A
Impact Slide Hammer	T50T-100-A
Engine Cylinder Hone Set	T73L-6011-A
Grit Abrasives, 200 (Set of 3)	T73L-6011-A2
Camshaft Bearing Installer Set	T65L-6250-A
Collet	T71P-6250-A
Engine Plug Replacer	T74P-6015-A

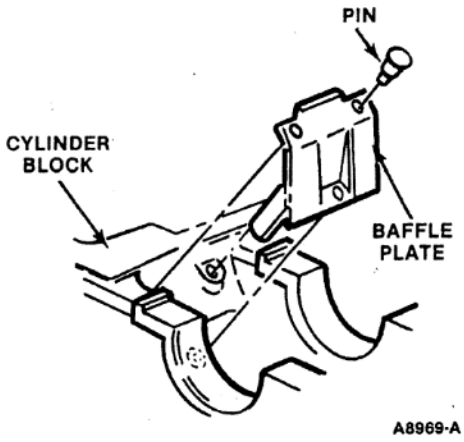
Disassembly

1. Remove the auxiliary shaft bearings, using Puller Attachment Tool T58L-101-A and Impact Slide Hammer T50T-100-A.

2. Remove the oil passage plugs from the ends of the cylinder block.



3. Remove the oil separator baffle plate from between No. 3 and 4 main bearing webs.



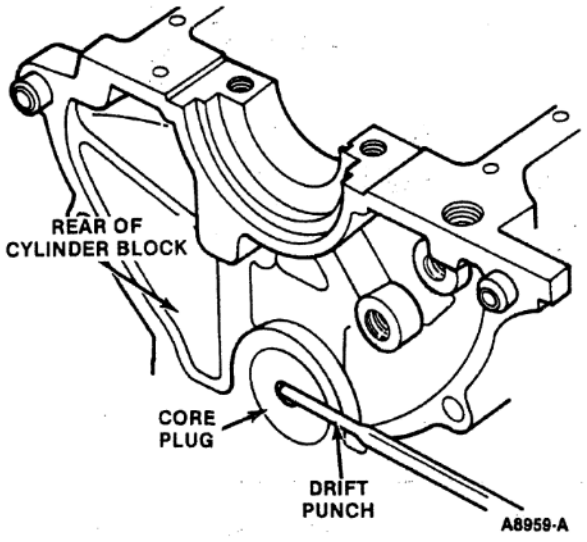
CLEANING, INSPECTION, AND OVERHAUL

CYLINDER BLOCK

Disassembly (Continued)

4. Remove the water jacket core plugs from the rear and right side of the cylinder block.

   To remove the plug, drill a hole in it and, using a large punch or pointed pry bar, pry the plug out.



Cleaning

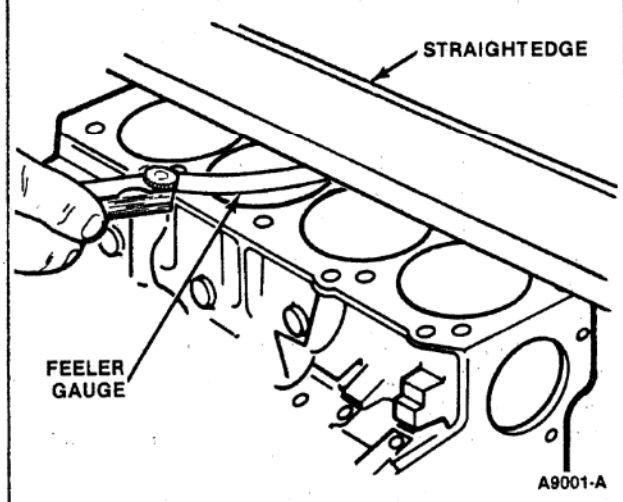
The cylinder block may be cleaned by immersing it in a cleaning vat, using a commercial cleaning solution. The block may also be cleaned with automotive parts cleaning solvents and brushes or by steam cleaning. Be sure to clean all oil passages and remove all gasket material, cements, and sealers from their surfaces.

It is also advisable at this time to clean the cylinder head bolt holes in the block by turning a grease-coated tap fully into the holes. Then clean the holes again and oil them.

If the cylinder block is not inspected or assembled in a day or two, then coat the cylinder and bearing bores with engine oil to prevent rust.

Inspection

The cylinder block cylinder head surface must be flat within .0762 mm (.003 in.) in any 152.4 mm (6 in.) area. Use a straightedge and a feeler gauge to determine the flatness.



If the flatness is out of specification, the cylinder block head surface can be ground a maximum of .254 mm (.010 in.) or the cylinder block must be replaced.

Inspect the cylinder block for cracks in the cylinder bores and between cylinders. Also look for cracks at the water pump opening and in the main bearing web area. If cracks are suspected that cannot be seen with the eye, there are magnetic and dye check inspection processes available through automotive machine shops. Be sure the water jacket core plug opening is clean and not damaged.

If difficulty is encountered in rotating the crankshaft when fitting new bearings or an unusual wear pattern is noticed on the main bearings, the problem may be a distortion in the main bearing bore alignment. This can only be corrected by line-boring or cylinder block replacement.

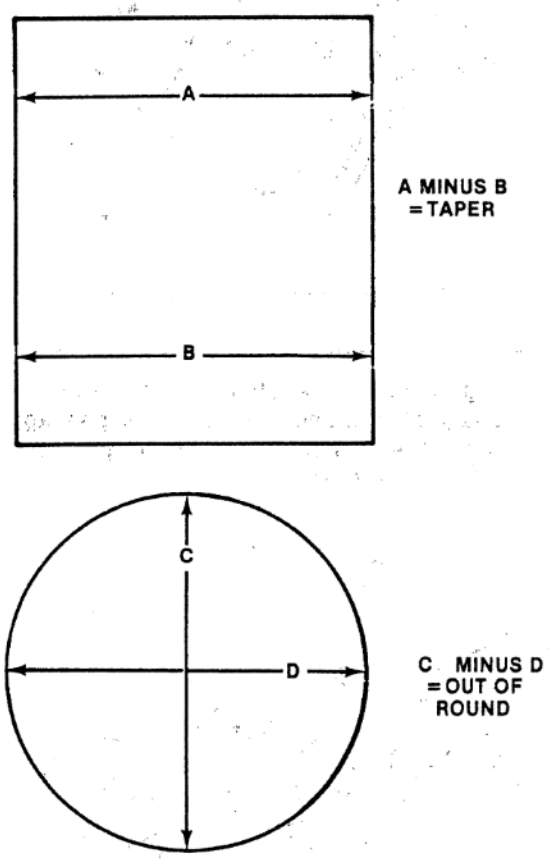
Also, inspect the cylinder bores for wear. They must be round, straight (sides parallel), and the diameter matched to the piston size.

CLEANING, INSPECTION, AND OVERHAUL

CYLINDER BLOCK

Inspection (Continued)

To determine if the cylinder bore is round within specifications, measure the bore about 25.4 mm (1 in.) below the top of the cylinder block and at a point below the piston ring travel. The measurements are taken in-line with the crankshaft centerline and 90 degrees to the crankshaft (across the cylinder block bore). The difference between the block lengthwise bore dimension and the across-the-bore dimension is the amount of out-of-round.



CYLINDER BORE DIAGRAM

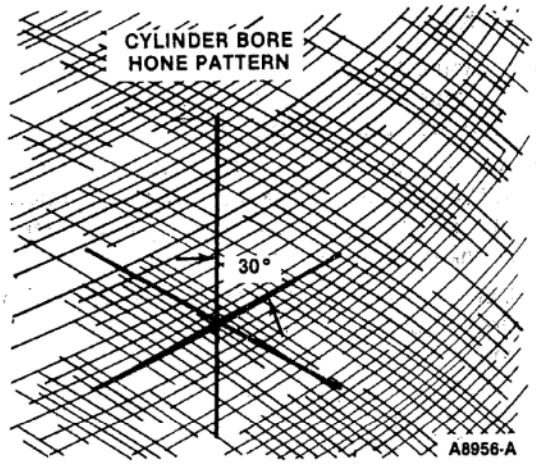
A8957-A

The difference of the across-the-cylinder block bore top and bottom measurements is the amount of bore taper. Usually the across-the-bore dimension is the greatest because of wear caused by piston thrust force. Allowable limit of out-of-round is 0.127 mm (.005 in.) and 0.254 mm (.010 in.) for taper.

Overhaul

If the bore out-of-round or taper dimensions exceed the specifications, then cylinder boring is required. This operation must be coordinated with piston selection. It is good practice to procure the pistons before boring the block. Then bore according to piston size.

Follow the boring equipment manufacturer's instructions for proper use. Allow .0635 mm (.0025 in.) for final honing to size and to give a proper cross-hatch pattern of approximately 30 degrees. A newly fit piston should have a piston-to-bore clearance of 0.0030 to 0.0038 in.



CAUTION: Do not allow the hone to come out of the cylinder bore while it is turning. The stones could be released and cause injury.

If the cylinders do not require boring, the cylinder walls should be prepared for a new set of piston rings by honing. A 180 to 220 grit stone hone, T73L-6011A and T73L-6011-A2, or equivalent, turning approximately 450 rpm and cycled (once up and down is a cycle) one time a second produces a satisfactory pattern. This operation should produce a surface finish (smoothness) of 8-24 CLA. Do not hone more than enough to produce a pattern the full length of the bore.

CLEANING, INSPECTION, AND OVERHAUL

CYLINDER BLOCK

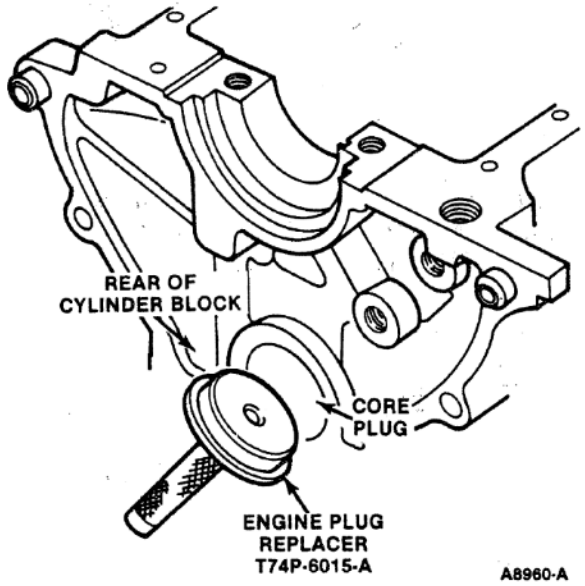
Overhaul (Continued)

A cylinder wall taper condition can be corrected through the use of an adjustable (non-flexible) hone. Use it in the same manner as the flexible hone, but it must be adjusted larger as the operation continues.

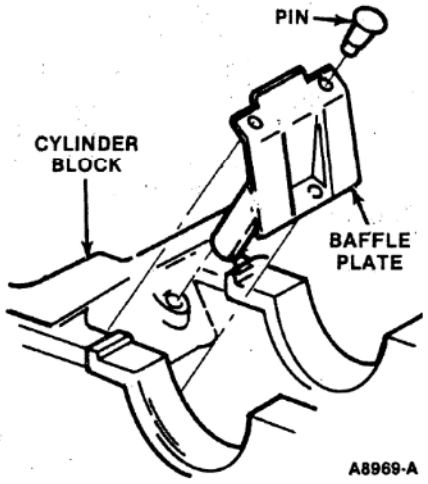
When the cylinder is sized and prepared for the piston, wash it thoroughly with detergent and hot water until a light-colored, lint-free cloth wiped through the bore comes out clean. Then oil the cylinder walls with engine oil.

Assembly

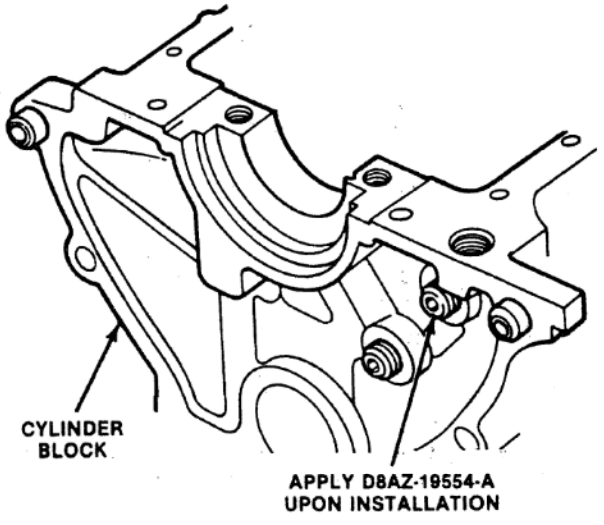
1. Measure the water jacket core plug hole at the rear of the cylinder block and select a plug that is the proper size.
2. Apply a 3.175-mm (1/8-in.) bead of D8AZ-19554-A sealer to the plug sealing diameter of the water jacket core plug hole at the rear of the cylinder block.
3. Using engine Plug Replacer T74P-6015-A, drive the plug in place until it bottoms in the bore.



4. Using new pins, install the oil separator baffle plate onto the cylinder block between the No. 3 and 4 main bearing webs.



5. Using sealer D8AZ-19554-A on the oil passage plug threads, install the oil passage plugs in the cylinder block and torque them to 31 to 38 N·m (23 to 28 lb-ft).

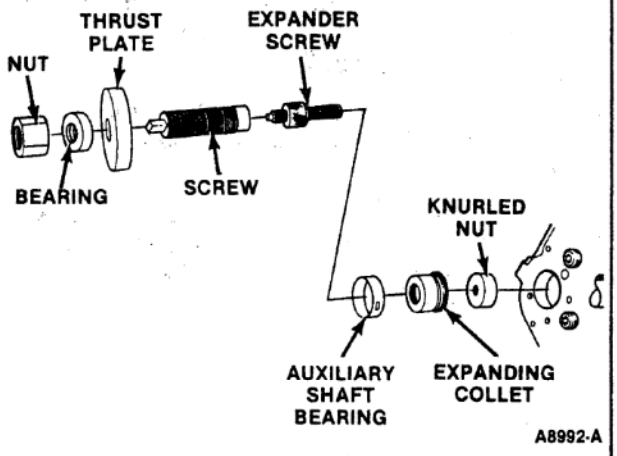


CLEANING, INSPECTION, AND OVERHAUL

CYLINDER BLOCK

Assembly (Continued)

6. Procure a new set of auxiliary shaft bearings. Coat the bearings and the cylinder block shaft bores with engine oil.
7. Oil the auxiliary shaft bearing bores in the cylinder block. Assemble a new auxiliary shaft bearing onto the Expanding Collet of Cam Bearing Replacer T71P-6250-A. Place Expander Screw T65L-6250-A13 through the Expanding Collet and thread into the Knurled Nut (part of Cam Bearing Replacer T71P-6250-A) until tight. Do not expand the cam bearing.



8. Place the bearing and tool assembly in a starting position on No. 2 bearing bore with the bearing oil hole aligned with the oil hole in the bearing bore. Oil the bearing.
9. Thread the screw onto the expander screw until fully seated. Slide the thrust plate (from Camshaft Bearing Set T65L-6250-A) and the bearing, from the same set, onto the opposite side of the auxiliary shaft bearing bore. Start and screw the nut on the screw until it contacts the bearing. While holding the screw with a wrench, tighten the nut until the auxiliary shaft bearing is centered into the bearing bore, and the bearing and cylinder block oil holes are aligned. Remove the tools and repeat with the other bearing.

On the front bearing installation, care must be taken to allow .000 to .254 mm (.000 to .010 in.) clearance between the front face of the bearing bore and the bearing. The clearance is to prevent interference with the auxiliary shaft thrust plate installation.

CRANKSHAFT

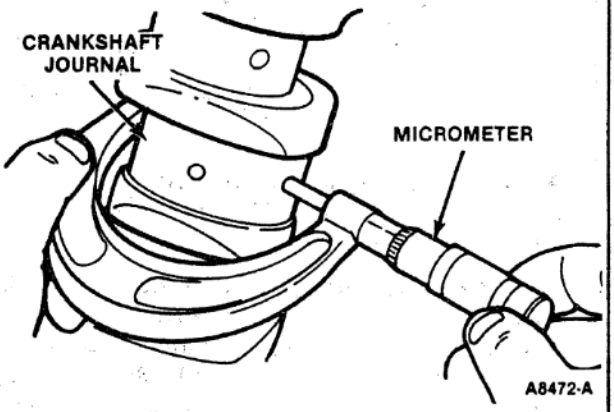
Cleaning

Clean the crankshaft with hot or cold commercial tank solutions, solvents and brushing, or by steam cleaning. Be sure to clean the drilled oil passages that connect the main and connecting rod journals.

Inspection

After cleaning, the crankshaft must be inspected to determine if it must be reconditioned or replaced.

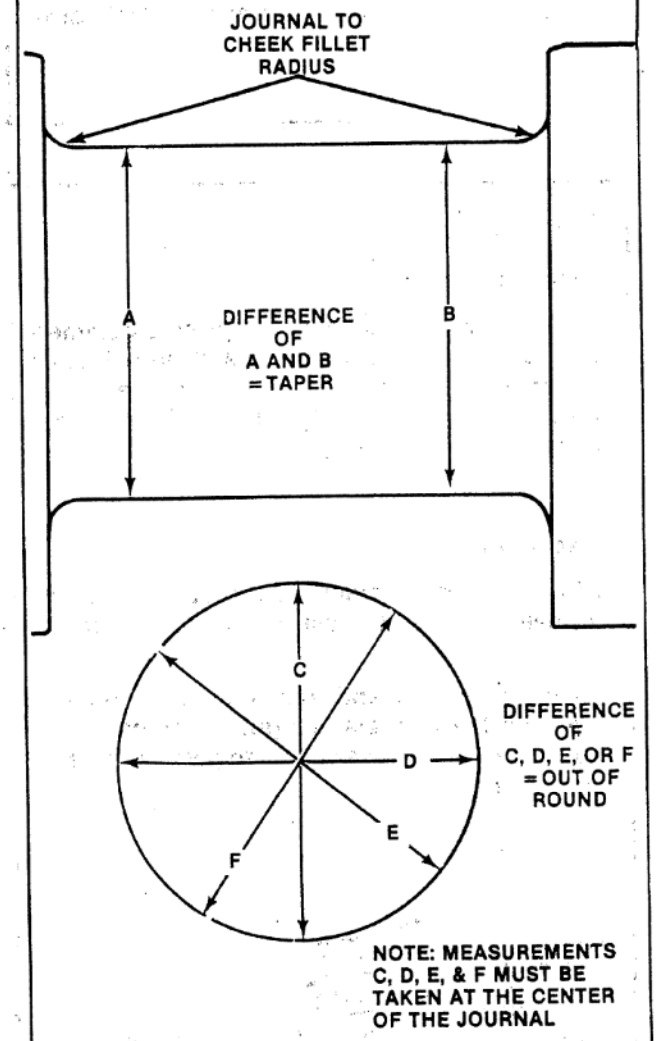
Measure the main and connecting rod journals. Measure the journals in eight locations. Write down the figures on a sketch to give a profile of each journal.



CLEANING, INSPECTION, AND OVERHAUL

CRANKSHAFT

Inspection (Continued)



A study of the readings will tell if the crankshaft is usable as is, and if it must be ground or must be replaced.

The main bearing journal specification is 60.9346 to 60.91428 mm (2.399 to 2.3982 in.). Allowable main bearing clearance is .02032 to .06604 mm (.0008 to .0026 in.). Main bearing journal out-of-round limit is .01524 mm (.0006 in.) maximum. Standard main bearing wall thickness is 2.42824 to 2.41554 mm (.0956 to .0951 in.). If the bearings are .002 in. undersize, add .001 to standard thickness.

The taper limit is .01524 mm (.0006 in.).

Maximum journal runout is .0508 mm (.002 in.) for a new or reground crankshaft and .127 mm (.005 in.) for serviced or used. A surface finish of 12 RMS maximum is required.

Thrust bearing journal length specification is 1.2010 to 1.1990 inches. Thrust bearing thrust face runout limit is .0254 mm (.001 in.).

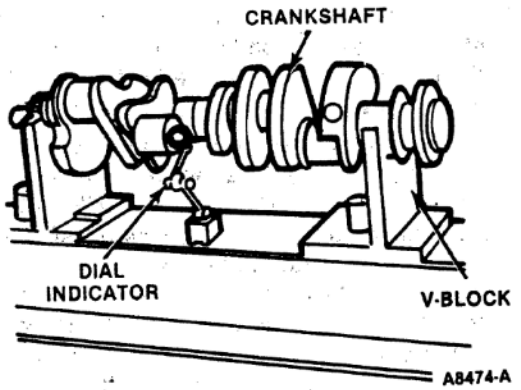
Connecting rod journal diameter is 51.9811 to 51.9989 mm (2.0465 to 2.0472 in.).

The connecting rod journal out-of-round limit is .01524 mm (.0006 in.). The taper limit is .01524 per 25.4 mm (.0006 per inch). Surface finish is 12 RMS maximum.

Standard connecting rod bearing wall thickness is 1.5723 to 1.5850 mm (.0619 to .0624 in.). If the bearings are .002 in. undersize, add .001 to standard thickness.

If the measurements show that the journals are within specifications, check that the crankshaft is straight.

This is done by first supporting the crank in V-blocks on the end main bearing journals. Set up a dial indicator to read on the center main bearing journal.



CLEANING, INSPECTION, AND OVERHAUL

CRANKSHAFT

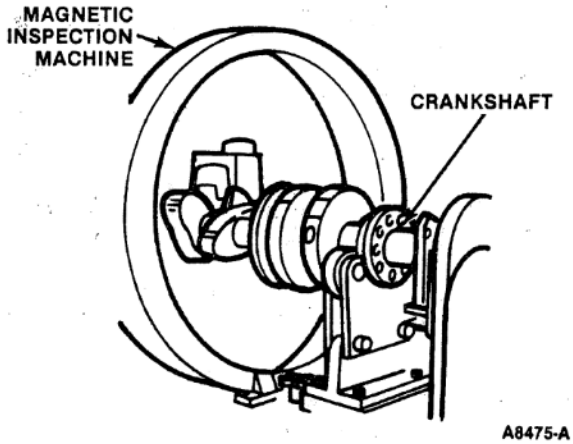
Inspection (Continued)

Be sure that the journal surfaces are smooth. Rotate the crank one revolution. Note the maximum variation of the indicator reading. This is the runout of the crankshaft in the center or amount of bow. Consider out-of-round journals when measuring runout. Mark the crankshaft at its high or low reading position. Then support the crank on the center and one end journal. Repeat the above procedure, taking the reading on the unsupported end journal. Record this reading.

Repeat the last setup on the opposite end journal.

If you study the above readings and marks, you will know if, where, and how much the crankshaft is bent. Most automotive machine shops are equipped to straighten crankshafts.

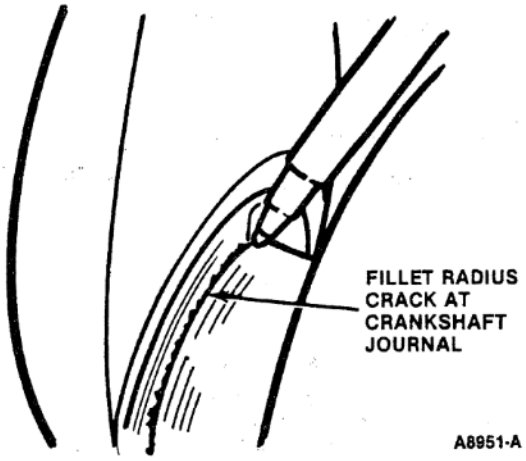
If the crankshaft has been subjected to or will be subjected to high-stress operation, one should consider a magnetic inspection of the crank for cracks that cannot be seen with the eye. This service is available through most automotive machine shops.



Overhaul

Crankshaft grinding is necessary to straighten and restore journals to a round condition. Crankshaft grinding should be done only by experienced professionals.

Maintaining the original fillet radius at the line where the journal meets the cheek of the crankshaft is very important. Failure to do so can result in crankshaft breakage.



Also be sure the crank is polished and recleaned, especially the oil passages, after grinding and before installing it in the engine.

Always store a crankshaft by standing it on end. It can bend when laid flat.

CLEANING, INSPECTION AND OVERHAUL

CONNECTING ROD AND PISTON

SPECIAL SERVICE TOOLS REQUIRED:

Piston Pin Removing/ Installing Set	D81L-6135-A
Piston Ring Groove Cleaner	D81L-6002-D

Disassembly

Note and record or mark the relation of the front (notch) of the piston to the numbered side of the connecting rod. This is important for correct reassembly.

Also keep the connecting rods and caps with matching numbers together. Be careful to use the proper tools to disassemble and assemble the piston, piston pin, and connecting rod. Extensive damage can result if the wrong tools are used. The piston pins in this engine are an interference press fit in the connecting rod. The bearing surface is between the piston pin bore of the piston and the piston pin.

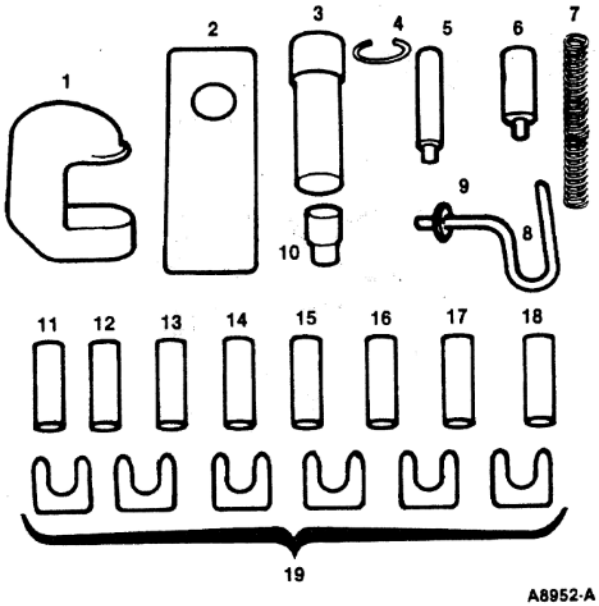
The proper tools for disassembling the connecting rod and piston are contained in the OTC Piston Pin Removing/Installing set.

Removing/Installing Set D81L-6135-A

CAUTION: The tooling is designed to operate properly up to 10 ton capacity. Exceeding this capacity could damage, bend or break component parts.

PARTS LIST

ITEM NO.	PART NO.	QUANTITY REQ'D	DESCRIPTION
1	302186	1	ANVIL
2	17929	1	BASE
3	17931-B	1	TUBE GUIDE
4	17945	1	RETAINING RING
5	17935	1	DRIVER
6	17932-B	1	BODY GUIDE
7	17934	1	SPRING
8	302224	1	REAR SUPPORT
9	10589	1	WING NUT
10	17930-B	1	THREADED PLUG
11	17940	1	PIN GUIDE
12	17936	1	PIN GUIDE
13	17937	1	PIN GUIDE
14	17938	1	PIN GUIDE
15	17939	1	PIN GUIDE
16	17941	1	PIN GUIDE
17	17942	1	PIN GUIDE
18	18729	1	PIN GUIDE
19	39889	1	INSERT ("1")
	39890	1	INSERT ("2")
	39888	1	INSERT ("3")
	39886	1	INSERT ("4")
	39887	1	INSERT ("5")
	39922	1	INSERT ("6")



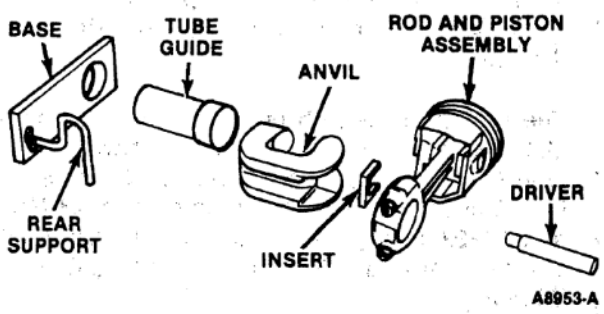
CLEANING, INSPECTION AND OVERHAUL

CONNECTING ROD AND PISTON

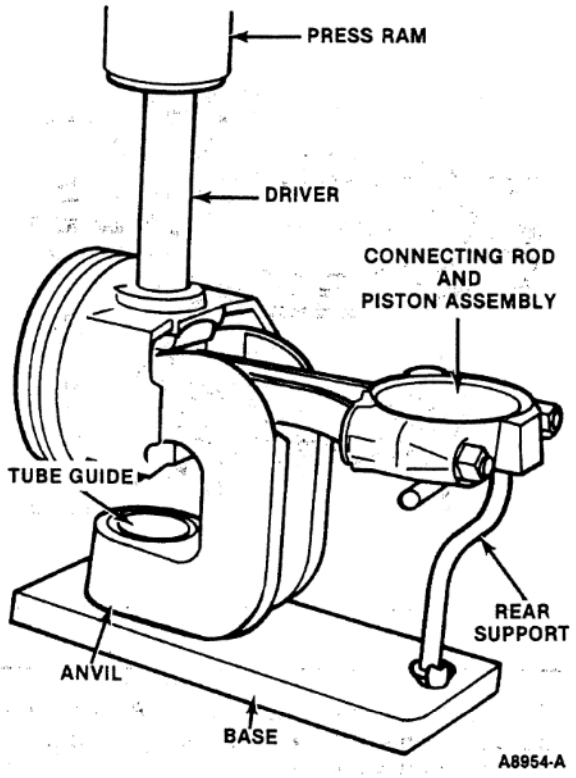
Disassembly (Continued)

To disassemble the connecting rod and piston, proceed as follows:

1. Assemble the anvil, tube guide, and threaded plug onto the base and press plates of an arbor press.



2. Select one insert that best fits around the piston pin and fills the space between the connecting rod and the inside piston pin boss of the piston.
3. Place the insert into the anvil opening with the open end of the insert facing the open side of the anvil.
4. Position the rod and piston assembly onto the anvil and insert. The anvil and insert should contact as much of the connecting rod pin boss as possible.
5. Adjust the rear support to position the connecting rod in a horizontal position so the press ram and the piston pin are in line.
6. Position the driver tool onto the top of the piston pin and under the arbor press ram.



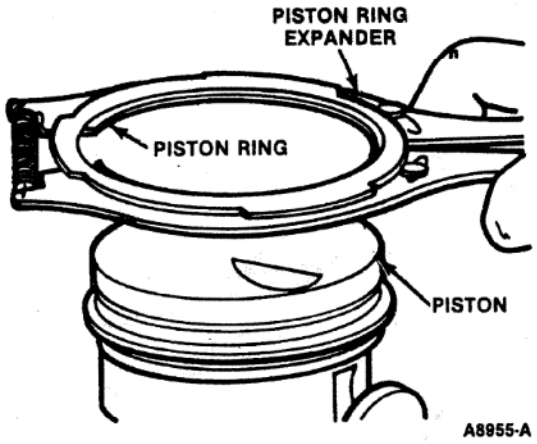
7. Apply press ram pressure and press the piston pin out of the connecting rod and piston. The piston pin should enter the tube guide. Adjust the piston and rod position on the anvil if necessary to align with the tube guide. Keep the piston pin with the piston it came from.

CLEANING, INSPECTION AND OVERHAUL

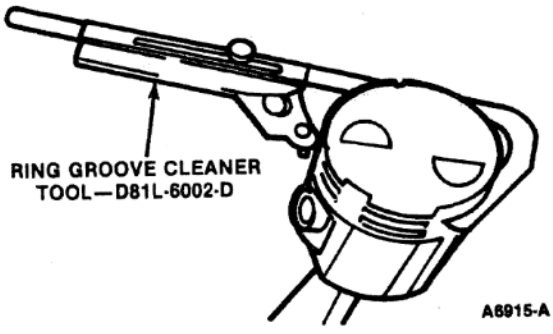
CONNECTING ROD AND PISTON

Cleaning

Remove the piston rings with a piston ring expander. Do not scratch the pistons.



Clean the ring grooves with a Piston Ring Groove Cleaner D81L-6002-D, or equivalent. Do not cut into the piston metal.

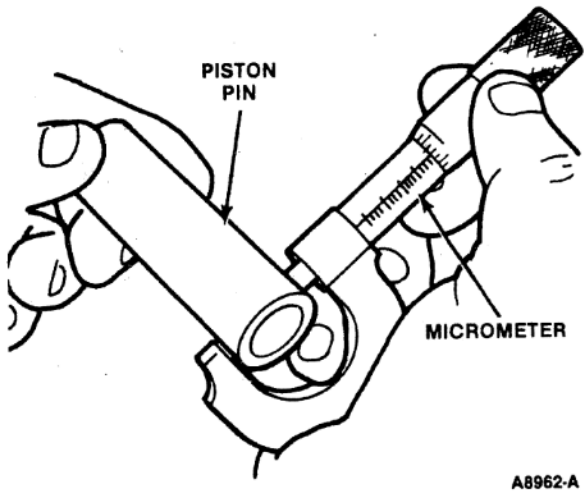


Carbon may be cleaned from the top of the piston with a wire brush or wheel. Do not use a wire wheel on the ring grooves or lands. Clean the oil drain holes in the oil ring grooves. Do not drill additional oil drain holes. Clean the remainder of the piston with solvent and a brush. Do not use a caustic (lye base) or acid cleaning solution.

Inspection

Inspect the piston for scores, cracks, excessively worn piston pin bores, pitted or eroded dome, worn piston ring grooves, and piston skirt diameter.

The piston pin length is 76.454 to 77.216 mm (3.010 to 3.040 in.). The piston pin bore dimension is 23.1724 to 23.1800 mm (.9123 to .9126 in.). Standard piston pin diameter is 23.1597 to 23.2232 mm (.9118 to .9143 in.). Piston to pin clearance is .0076 to .0127 mm (.0003 to .0005 in.).

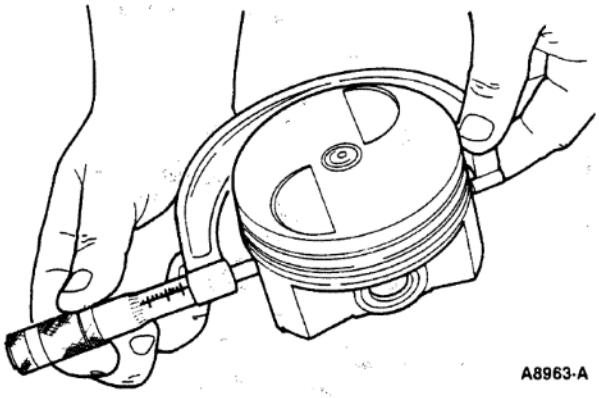


CLEANING, INSPECTION AND OVERHAUL

CONNECTING ROD AND PISTON

Inspection (Continued)

Piston skirt diameter at the piston pin center and 90 degrees to the pin axis is 95.9206 to 95.9358 mm (3.7764 to 3.7770 in.) for a standard red coded piston, 95.9510 to 95.9663 mm (3.7776 to 3.7782 in.) for a standard blue coded piston, 95.9815 to 95.9968 mm (3.7788 to 3.7794 in.) for a .0762 mm (.003 in.) oversize piston.



NOTE: The piston-to-cylinder bore clearance is .0762 to .0965 mm (.0030 to .0038 in.). Piston and cylinder bore sizes must be coordinated to result in the proper clearance.

Piston ring groove width dimensions are 2.0320 to 2.0574 mm (.080 to .081 in.) for the top two ring grooves and 4.7752 to 4.8006 mm (.188 to .189 in.) for the oil ring groove.

Piston ring-to-groove side clearance is .0508 to .1016 mm (.002 to .004 in.) for the top two compression rings and zero clearance or a snug fit for the oil ring and groove.

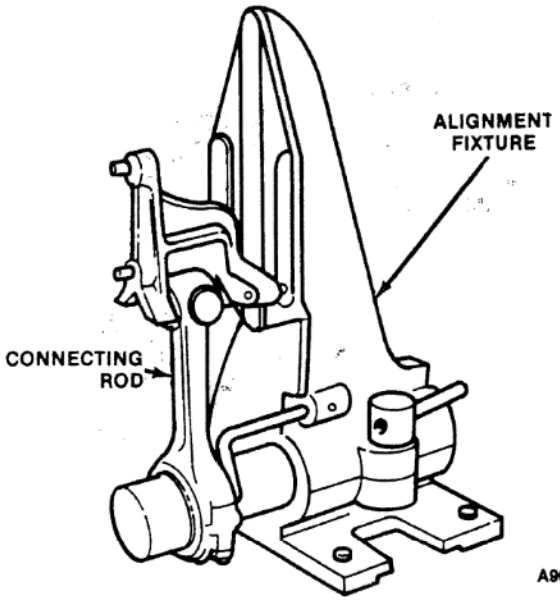
Connecting Rod Cleaning

Connecting rods may be cleaned in hot or cold commercial tank-type cleaners. They may also be cleaned with automotive parts cleaning solvents or steam cleaned.

Connecting Rod Inspection

The connecting rods should be inspected for proper piston pin bore diameter, crankshaft bearing bore diameter, length, bend, and twist.

The piston pin bore diameter specification is 23.1038 to 23.1191 mm (.9096 to .9102 in.). Crankshaft bearing bore diameter is 55.1688 to 55.1891 mm (2.1720 to 2.1728 in.). The crankshaft bearing bore out-of-round limit is .0102 mm (.0004 in.). Center-to-center length is 132.1587 to 132.2400 mm (5.2031 to 5.2063 in.). Allowable twist is .6096 mm (.024 in.) and bend is 3.048 mm (.012 in.). Piston pin bore diameter and crankshaft bearing bore diameters can be measured with inside micrometers. Connecting rod center-to-center length, twist and bend measurements require special fixtures that are not normally available at a dealership or vehicle repair facility. Automotive machine shops usually do this type of work.



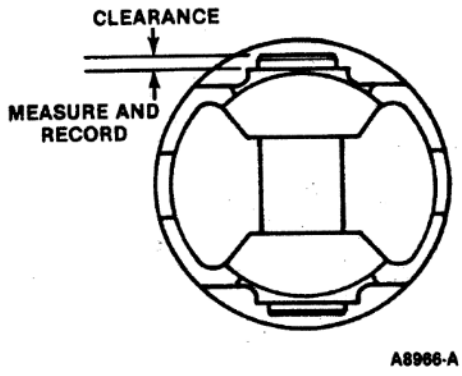
CLEANING, INSPECTION AND OVERHAUL

CONNECTING ROD AND PISTON

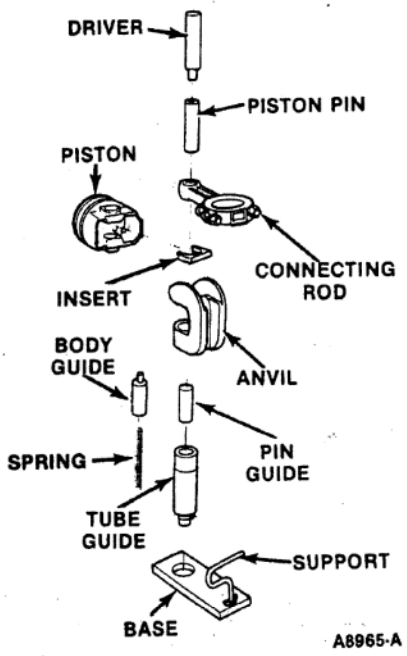
Assembly

The assembly of the piston and connecting rod will require the use of the OTC Piston Pin Removing/Installing Set D81L-6135-A.

1. Install the threaded plug into the tube guide approximately half of its thread length.
2. Select the largest pin guide that will pass through the connecting rod pin bore. Install the spring, body guide and pin guide into the tube guide.
3. Insert the piston pin into the piston pin bore of the piston; measure the amount that the piston pin protrudes evenly on each side of the piston. Record that figure.



4. Remove the pin and position the connecting rod and piston on the insert and anvil. The insert selected will be one that best fits the piston pin and fills the space between the connecting rod and piston. The spring-loaded pin guide will pass through the piston and rod and align it. Lubricate the piston pin and insert it into the piston.



5. Place the piston pin driver onto the piston pin and move the piston and pin into position under the arbor press ram. Push the piston pin through the connecting rod until it protrudes the distance recorded in step 3. Check that the piston is free on the piston pin while installing the pin.
6. When the piston pin to piston dimension is correct, keep a slight pressure on the press ram. Thread the threaded plug into the tube guide until it contacts the body guide.
7. Remove ram pressure and check the piston pin to piston dimension. Readjust if necessary and reset the threaded plug. The threaded plug is now set to gauge the remainder of the rod/piston assemblies.

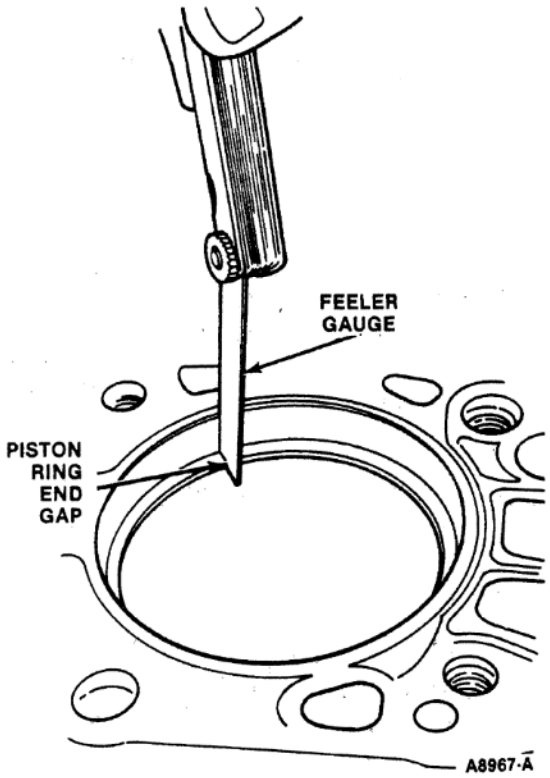
CLEANING, INSPECTION AND OVERHAUL

CONNECTING ROD AND PISTON

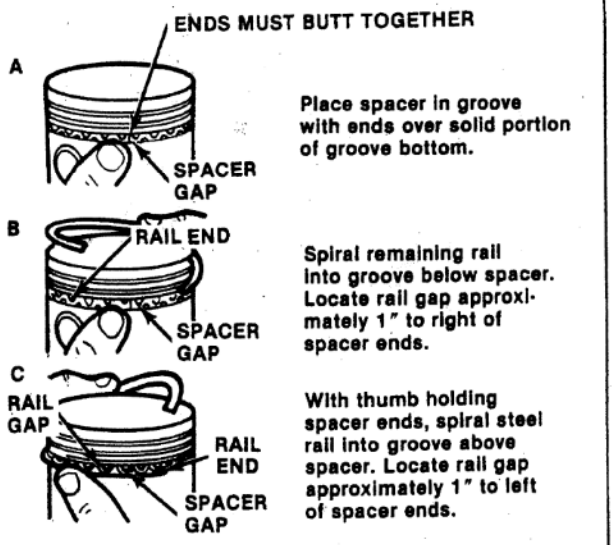
Piston Ring Installation

Before installing the piston rings on the pistons, they must be checked for proper end gap clearance.

1. Start a compression ring into the cylinder bore in which it will finally be installed.
2. Using a piston without piston rings on it, push the top of the piston into the bore and slide the ring into the bore until the ring is approximately midway down the cylinder bore. Remove the piston.
3. Measure the piston ring end gap with a feeler gauge.



4. The end gap for the compression rings is .254 to .508 mm (.010 to .020 in.) and for the oil ring steel rails the gap is .381 to 1.397 mm (.015 to .055 in.).
5. Repeat steps 1 through 3 for all piston rings in their proper bores.
6. If the gap is too large, select another piston ring. If the gap is too small, clamp the ring in a soft jawed vise and carefully file the gap slightly. Recheck the gap in the cylinder bore.
7. Roll the compression rings around the piston ring grooves to check for burrs or bent ring grooves. Check the ring groove to ring side clearance with a feeler gauge. The compression ring clearances are .0508 to .1016 mm (.002 to .004 in.) and the oil ring clearance is zero or snug.
8. Install an oil ring spacer in the bottom ring groove of the piston. The ends must butt one another and not overlap.



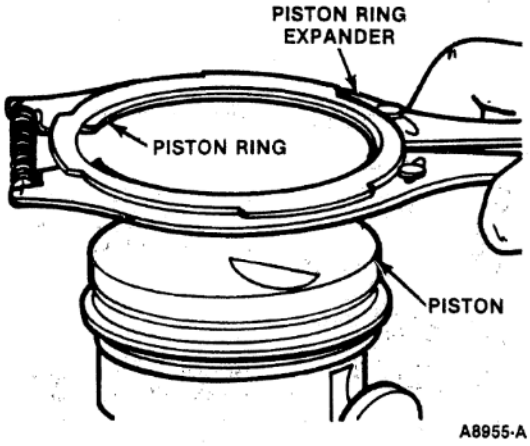
The ends must be on a solid portion of the piston (not over an oil drain hole.)

CLEANING, INSPECTION AND OVERHAUL

CONNECTING ROD AND PISTON

Piston Ring Installation (Continued)

9. Start the end of an oil ring rail ring into the oil ring groove above the spacer. The end gap must be approximately 25.4 mm (1 in.) away from the spacer ends. Finish installing the rail ring by spiraling it the remainder of the way on. Repeat the rail installation with the other rail ring. Its gap must be approximately 25.4 mm (1 in.) on the other side of the spacer ends.
10. Select the number two compression ring and install it in a piston ring expander with the proper side up. See instructions on the ring package. Spread the ring and install it in the piston ring groove.



Repeat step 10 with the top compression ring. Space the compression ring gaps approximately 50.8 mm (2 in.) on opposite sides of the oil ring gaps.

11. Oil the rings and piston pin bores. Store the rod/piston assemblies in a clean place until ready for assembly.

CYLINDER HEAD

SPECIAL SERVICE TOOLS REQUIRED:

Front Seals Replacer	T74P-6150-A
Camshaft Bearing Set	T65L-6250-A
Cam Bearing Replacer	T71P-6250-A
Expander Screw	T65L-650-A13
Cam Bearing Adapter Tube	T72C-650
Hydraulic Tappet Leakdown Tester	TOOL-6500-E
Valve Spring Compressor	T74P-6565-A
Front Cover Seal Remover	T74P-6700-B
Valve Guide Reamer Kit	T52L-6085-AEE
Valve Seat Runout Gauge	D81P-6002-E
Dial Indicator with Bracketry	TOOL-4201-C
Valve Stem Clearance Tool	TOOL-6505-E
Valve/Clutch Spring Tester	TOOL-6513-D
Valve Stem Seal Installer	T73P-6571-A

Disassembly

1. Before the cylinder head components are disassembled, support the head assembly, head gasket surface up, on a table or bench. Use blocks or pins to prevent valve or camshaft parts from contacting the table or bench.

   Clean the combustion chamber deposits with a wire wheel and a drill motor. Leave the valves in place to prevent damage to the valves or valve seats.

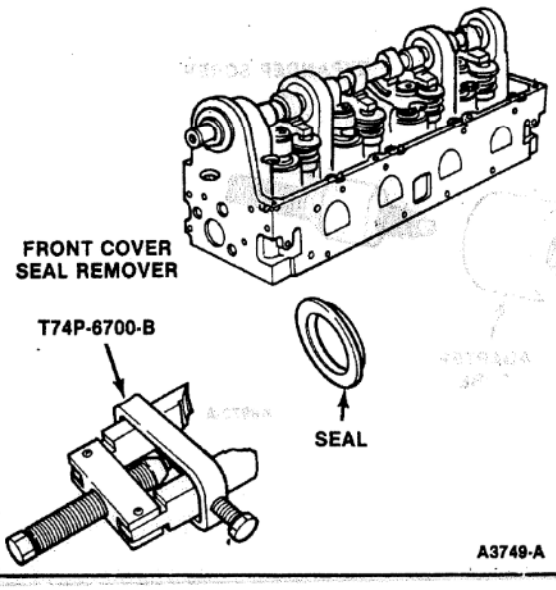
2. Turn the cylinder head camshaft side up and perform Base Procedure 10—Disassembly, Hydraulic Lash Adjusters Removal.

CLEANING, INSPECTION AND OVERHAUL

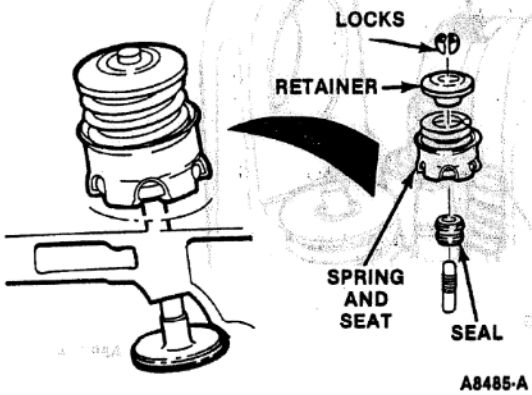
CYLINDER HEAD

Disassembly (Continued)

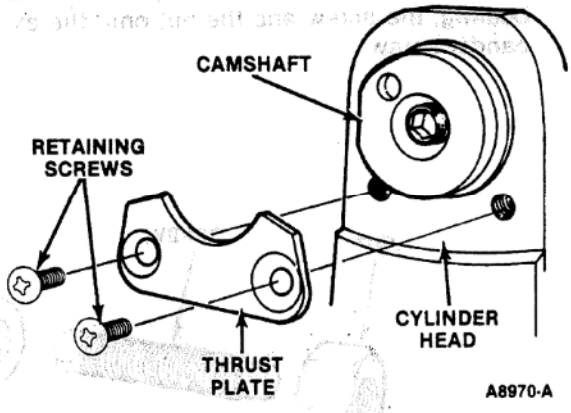
3. Remove the camshaft seal using Front Cover Seal Remover T74P-6700-B, or equivalent.



4. Turn the cylinder head on its side. Using a horseshoe type of valve spring compressor, depress the valve spring retainer and valve spring. Remove the locking keys, the spring retainer, valve spring and seal. Repeat on the remaining valves. Keep the valves in order so that they can be assembled in their original positions.

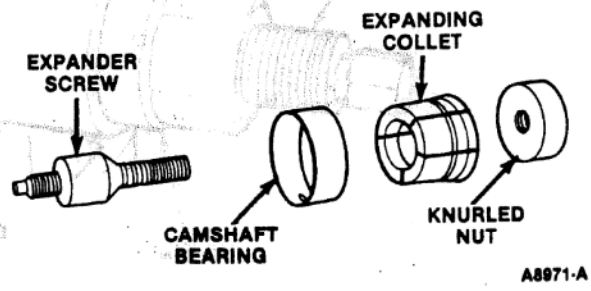


5. Remove the camshaft rear retaining and thrust plate screws and plate. Carefully slide the camshaft through its bearings and out the front of the cylinder head.



6. Remove the plug from the rear of the camshaft.
7. The camshaft bearings can most easily be removed by removing the number 3 and 4 bearings from the rear of the cylinder head and numbers 1 and 2 from the front of the head.
8. Install tools from Camshaft Bearing Set T65L-6250-A, Cam Bearing Replacer T71P-6250-A, and Cam Bearing Adapter Tube T72C-6250, or equivalents, into a camshaft bearing.

9. While holding the expander screw, tighten the round knurled nut until the expanding collet is firmly expanded into the cam bearing.

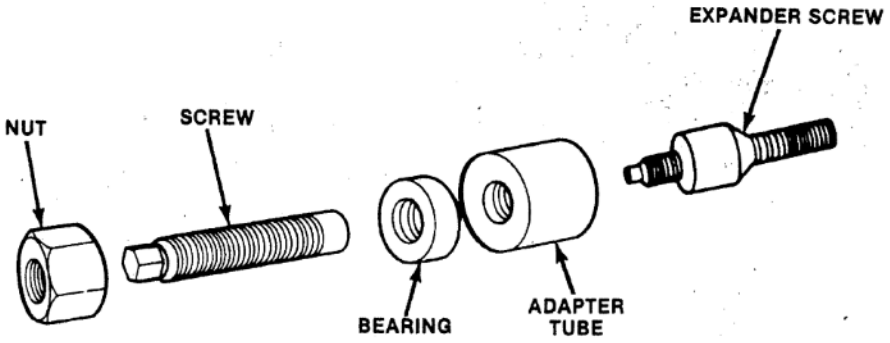


CLEANING, INSPECTION AND OVERHAUL

CYLINDER HEAD

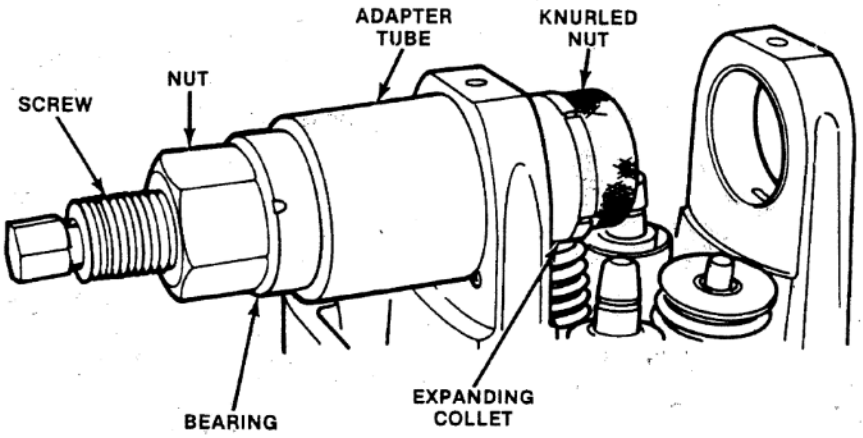
Disassembly (Continued)

10. Assemble the cam bearing adapter tube, the bearing, the screw and the nut onto the expander screw.



11. Hold the screw while tightening the nut until the camshaft bearing is pulled into the cam bearing adapter tube.

12. Repeat steps 7 through 10 on the remaining camshaft bearings.

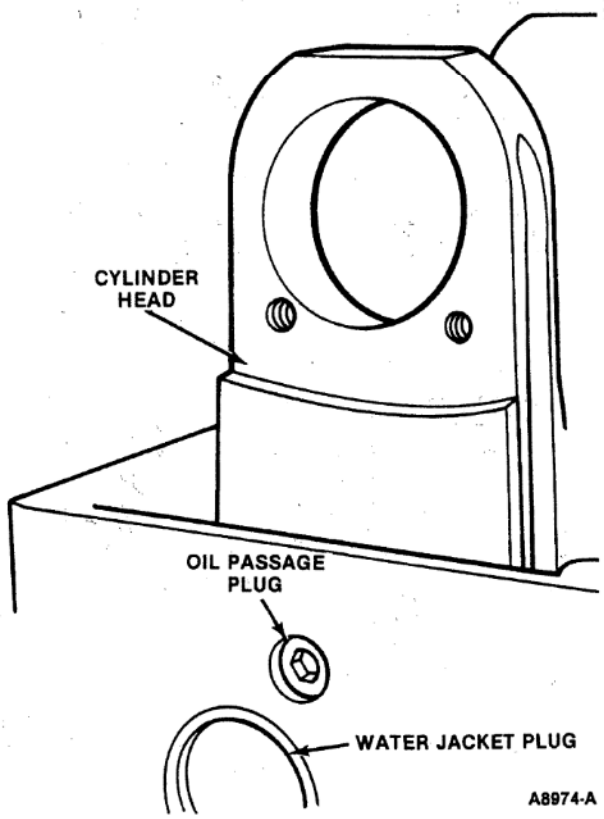


CLEANING, INSPECTION AND OVERHAUL

CYLINDER HEAD

Disassembly (Continued)

13. Remove the oil passage plugs from the ends of the cylinder head.



14. Remove the water jacket plug from the rear of the head by drilling a hole in it and prying it out with a drift or pointed bar.

Cleaning

The cylinder head may be cleaned through the use of commercial hot or cold tank-type cleaners, with automotive parts cleaning solvents, or by steam cleaning. Clean the intake and exhaust ports with a small wire wheel and a drill motor. Be careful not to allow the drill chuck to contact the valve seats.

Remove all gasket material from the rocker arm cover gasket surface, head gasket surface, the intake manifold surface, and the coolant outlet elbow surface.

Using a valve guide cleaning tool and a small bristle brush, clean the valve guide bores.

Clean the hydraulic lash adjuster holes and the cylinder head oil passages.

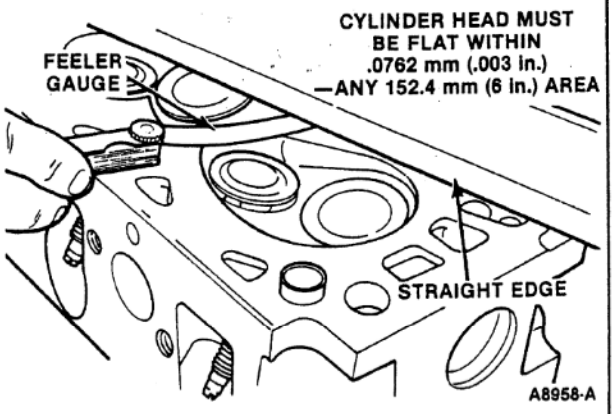
Clean the deposits from the valves with a wire wheel.

Remove deposits from the valve springs and retainers. If the valve springs are painted, do not use a wire brush or paint remover to clean them. They could rust, become pitted and break.

The camshaft may be cleaned by tank cleaning, solvents or by steam cleaning.

Inspection

Inspect the cylinder head for cracks in valve seats and ports, at coolant passage holes and between combustion chambers. Check the head for being flat on the head gasket surface. The head must be flat within .0762 mm (.003 in.) in any 152.4 mm (6 in.) area.

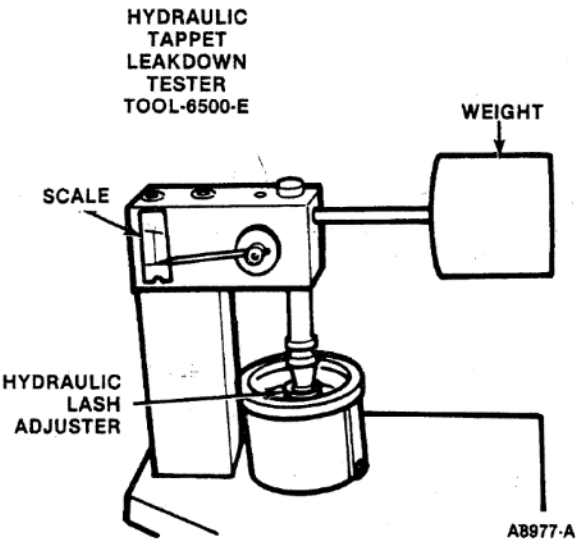


CLEANING, INSPECTION AND OVERHAUL

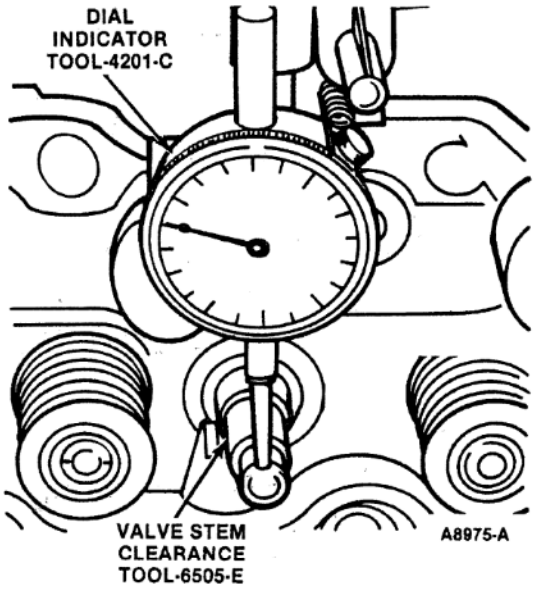
CYLINDER HEAD

Inspection (Continued)

Measure the hydraulic lash adjuster bores. The bore should be 21.4122 to 21.46046 mm (0.8430 to 0.8449 in.). The clearance between the bore and the adjuster should be .0178 to .0686 in. (.0007 to .0027 in.) with a maximum service limit of 0.127 mm (.005 in.). The adjuster outer body diameter should be 21.3919 to 21.4046 mm (.8422 to .8427 in.). The hydraulic lash adjuster should be checked for leakdown rate on the Hydraulic Tappet Leakdown Tester Tool L-6500-E, or equivalent. The leakdown rate is two to eight seconds for a travel of 3.175 mm (1/8 in.) with a 22.68 Kb (50 lb.) load applied. See instructions for use with the tool.



Inspect the valve guide bores for proper size. A telescoping gauge and a 25.4-mm (1-in.) micrometer should be used. The intake and exhaust guide bores should be 8.7198 to 8.7452 mm (.3433 to .3443 in.). Intake valve-to-guide clearance is .0254 to .0686 mm (.0010 to .0027 in.) on a new or overhauled head and a service limit of .1397 mm (.0055 in.) for intake and exhaust. The exhaust valve-to-guide clearance on a new or overhauled cylinder head should be .0381 to .0813 mm (.0015 to .0032 in.).



Check the valve stem to valve guide clearance of each valve in its respective valve guide with Valve Stem Clearance TOOL-6505-E and Dial Indicator TOOL-4201-C, or equivalent. Use a flat end indicator point.

Install the tool on the valve stem until it is fully seated, and tighten the knurled set screw firmly. Permit the valve to drop away from its seat until the tool contacts the upper surface of the valve guide.

Position the dial indicator with its flat tip against the center portion of the tool's spherical section at approximately 90 degrees to the valve stem axis. Move the tool back and forth in line with the indicator stem. Take a reading on the dial indicator without removing the tool from the valve guide upper surface. Divide the reading by two, the division factor for the tool. The resulting measurement is the valve stem clearance.

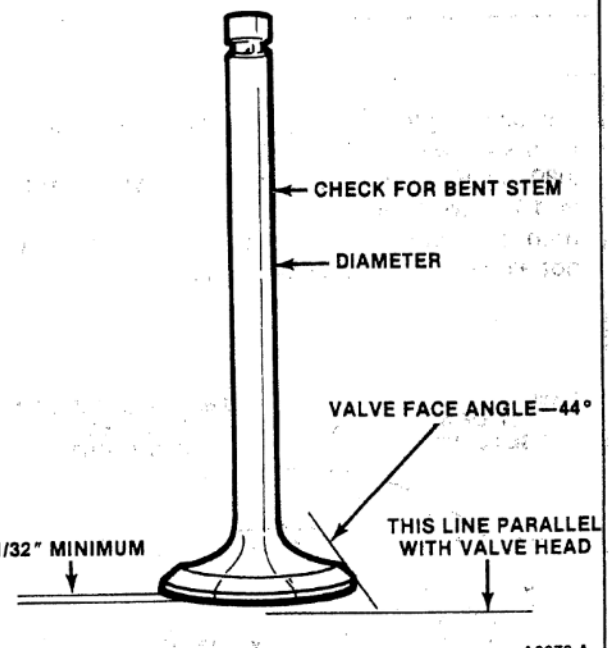
CLEANING, INSPECTION AND OVERHAUL

CYLINDER HEAD

Inspection (Continued)

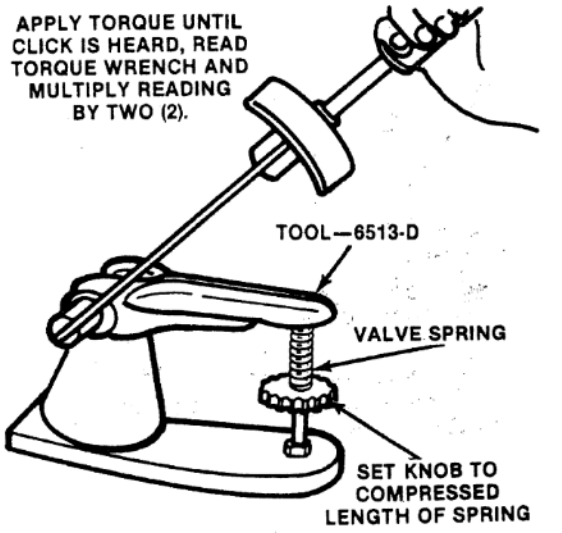
Intake valve stem diameters are 8.6766 to 8.6944 mm (.3416 to .3423 in.) on a standard valve, 9.0576 to 9.0754 mm (.3566 to .3573 in.) on a .381-mm (.015-in.) oversize valve stem, and 9.4386 to 9.4564 mm (.3716 to .3723 in.) on a .762-mm (.030-in.) oversize valve stem.

Exhaust valve stem diameters are 8.6639 to 8.6817 mm (.3411 to .3418 in.) for a standard valve stem, 9.0449 to 9.0627 mm (.3561 to .3568 in.) for a .381-mm (.015-in.) oversize stem and 9.4259 to 9.4437 mm (.3711 to .3718 in.) for a .762-mm (.030-in.) oversize stem. Intake and exhaust valve face angle limits are 44 degrees.



The valve key lock grooves in the valve stems should be inspected for having square corners on the grooves and lands.

Valve springs must be of a specified size and strength and not warped. Intake and exhaust valve springs are interchangeable. The valves themselves are not interchangeable.

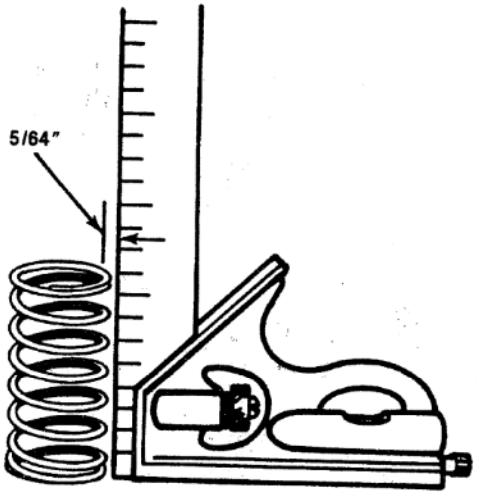


CLEANING, INSPECTION AND OVERHAUL

CYLINDER HEAD

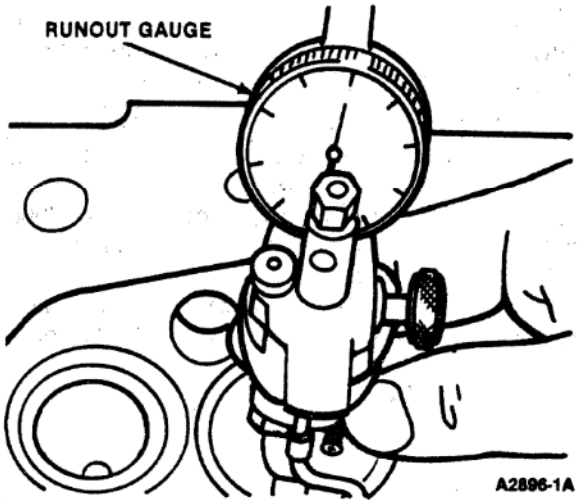
Inspection (Continued)

The valve spring pressures are: 32.2056 to 35.8344 kg (71 to 79 lbs) at 38.608 mm (1.52 in.). The free length is 47.6758 mm (1.877 in.) and assembled height is 38.894 mm to 40.481 mm (1-17/32 to 1-19/32 in. or 1.5313 to 1.5938 in.). A five-percent pressure loss is allowable at the above specified lengths. Springs must be square within 1.981 mm (5/64 or 0.078 in.).



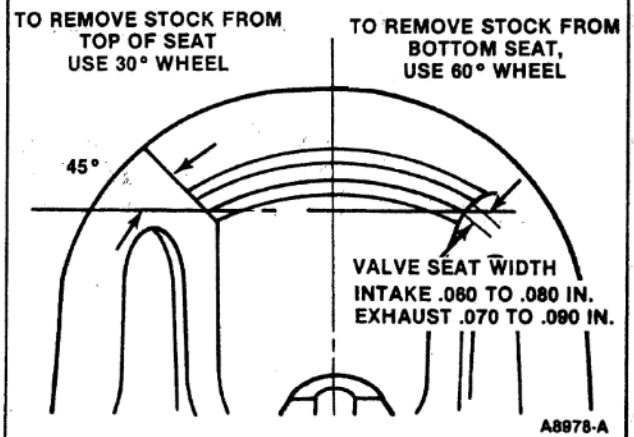
A8976-A

Cylinder head valve seats must be round, have the correct seat angle, face width, and be free of pits or burned areas.



A2896-1A

The seat angle is 45 degrees; the face width on intake valve seats is 1.524 to 2.032 mm (.060 to .080 in.). Face width on the exhaust valve seats is 1.778 to 2.286 mm (.070 to .090 in.). Face runout on intake or exhaust valve seats should not exceed .0406 mm (.0016 in.).



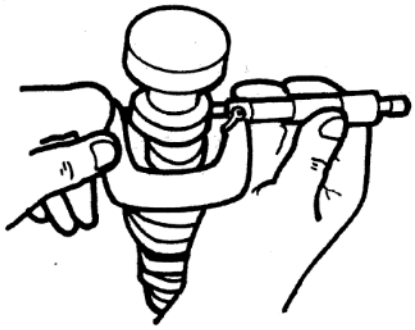
A8978-A

CLEANING, INSPECTION AND OVERHAUL

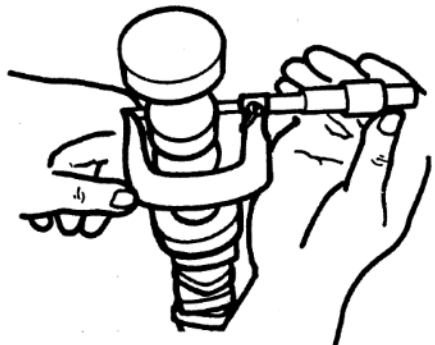
CYLINDER HEAD

Camshaft Inspection

Measure the camshaft lobes across their maximum (lobe height) and minimum (base circle) dimensions. The difference is the lobe lift. The intake and exhaust lobe lift should be 10.6 mm (0.400 in.) with a .127 mm (.005 in.) allowance.



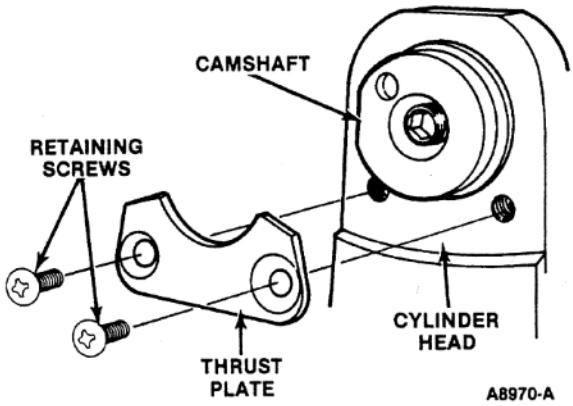
MEASURING ACROSS THE MAXIMUM OF A CAM LOBE



MEASURING ACROSS THE BASE CIRCLE OF A CAM LOBE A8980-B

MAXIMUM—MINIMUM (BASE CIRCLE) = CAM LOBE LIFT

Inspect the thrust plate groove and thrust plate, on the rear of the camshaft, for scoring or wear. Camshaft endplay specifications are .0254 to .1778 mm (.001 to .007 in.) with a maximum service limit of .2286 mm (.009 in.).



All of the camshaft bearing journals are the same size: 44.9910 to 45.0088 mm (1.7713 to 1.7720 in.). The allowable out-of-round on any one journal is .0127 mm (.0005 in.). Total indicated runout of the camshaft is .127 mm (.005 in.). Camshaft journal to bearing clearance is .0254 to .0762 mm (.001 to .003 in.) with a maximum service limit of .1524 mm (.006 in.).

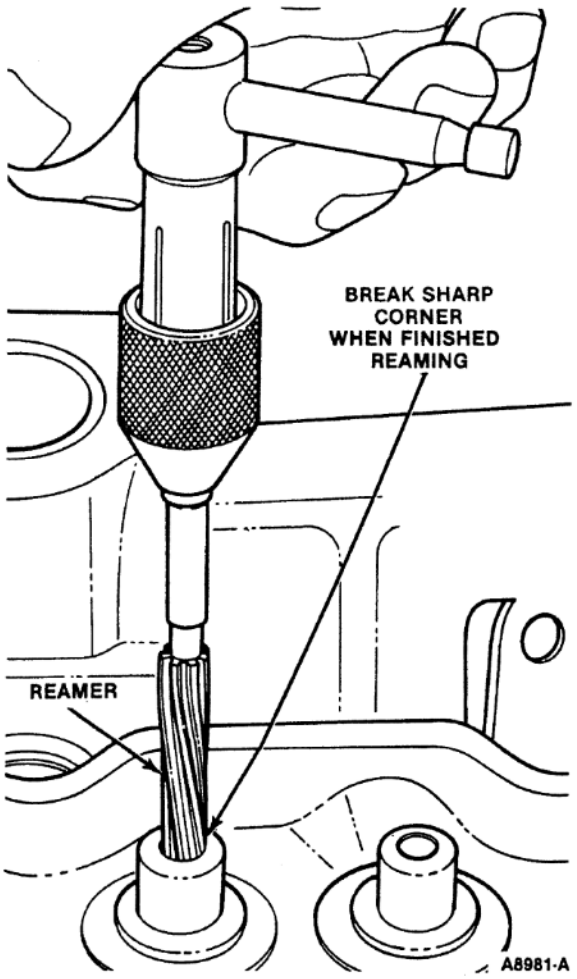
Check the camshaft follower for wear or scoring at the camshaft contact pad and at the valve end. If any scoring or grooves are present, replace the follower.

CLEANING, INSPECTION AND OVERHAUL

CYLINDER HEAD

Overhaul

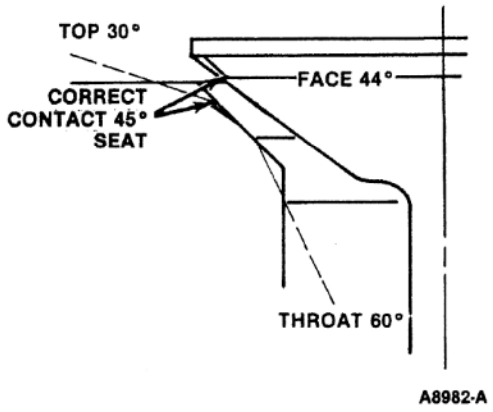
If necessary, ream the valve guides to match the necessary size valve stems using Valve Guide Reamer Kit T52L-6085-AEE, or equivalent.



The kit contains reamers for .0762, .381 or .762 mm (.003, .015 or .030 in.) oversize valve guides. Then, if necessary, grind the valve seats to a 45-degree angle. Follow the instructions of the seat grinding equipment manufacturer. Be sure to use a tight fitting, straight pilot in the valve guide. Do not remove more metal than necessary to clean the seat.

If necessary, reface the valves to a 44 degree angle following the valve grinding equipment manufacturer's recommendations. A minimum .794-mm (1/32-in.) margin at the edge of the valve head must remain after grinding. Remove as much stock from the end of the valve stem as the total removed from the seat and valve face. Bevel the edge of the valve stem end after grinding the end of the stem.

The center of the valve face should contact the seat in approximately the top ⅓ of the valve seat.



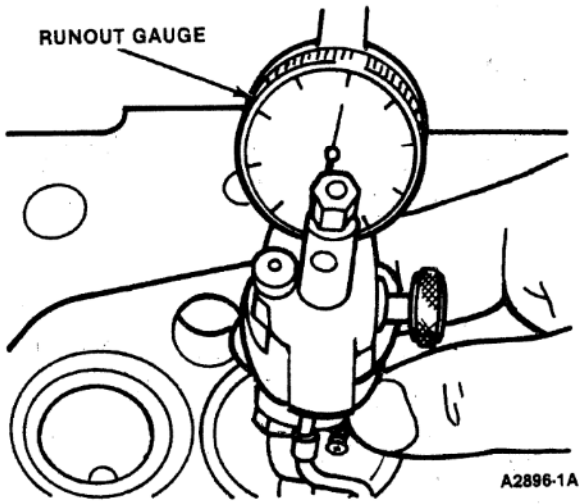
Lower the seat as required with a 15 or 30 degree stone seat cut. If contact is correct but the seat is too wide, trim the bottom of the seat with a 60 or 70 degree stone. After grinding, the seat will almost always be too wide, so some narrowing is usually necessary.

CLEANING, INSPECTION AND OVERHAUL

CYLINDER HEAD

Overhaul (Continued)

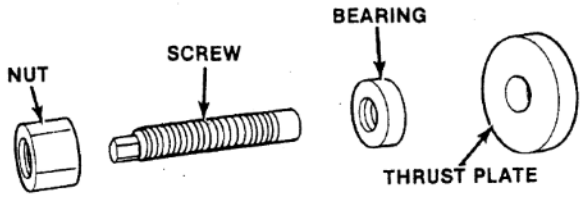
Before assembling the valves into the cylinder head, check the valve seat runout with Valve Seat Runout Gauge D81P-6002-E, or equivalent.



Rinse the cylinder head with detergent and hot water or solvent before proceeding with the next operation.

Place the bearing and tool assembly in a starting position on number 2 or 3 cam bearing bores with the bearing oil hole aligned with the oil hole in the bearing bore. Oil the bearing.

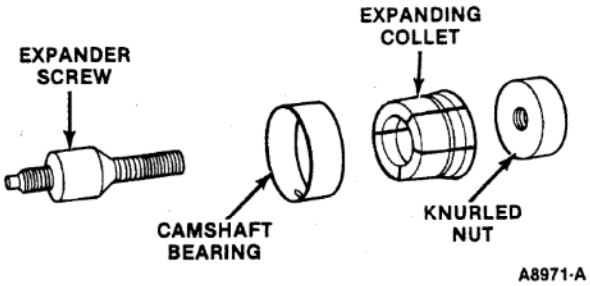
Thread the screw onto the expander screw until fully seated. Slide the thrust plate (from Camshaft Bearing Set T65L-6250-A) and the bearing, from same set, onto the opposite side of the camshaft bearing bore, start and screw the nut on the screw until it contacts the bearing.



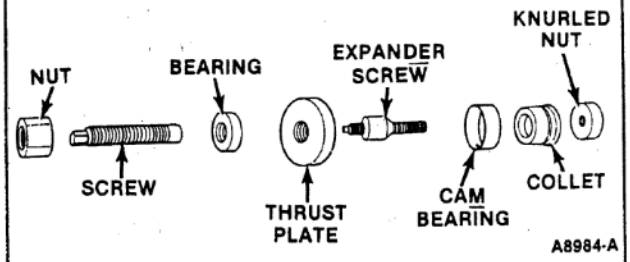
Camshaft Bearings Installation

Oil the camshaft bearing bores in the cylinder head.

Assemble a new camshaft bearing onto the expanding collet of Cam Bearing Replacer T71P-6250-A. Place Expander Screw T65L-6250-A13 through the expanding collet and thread into the knurled nut (part of Cam Bearing Replacer T71P-6250-A) until tight. Do not expand the cam bearing.



While holding the screw with a wrench, tighten the nut until the camshaft bearing is centered into the bearing bore and the bearing and head oil holes are aligned. Remove the tools and repeat with the other three bearings.

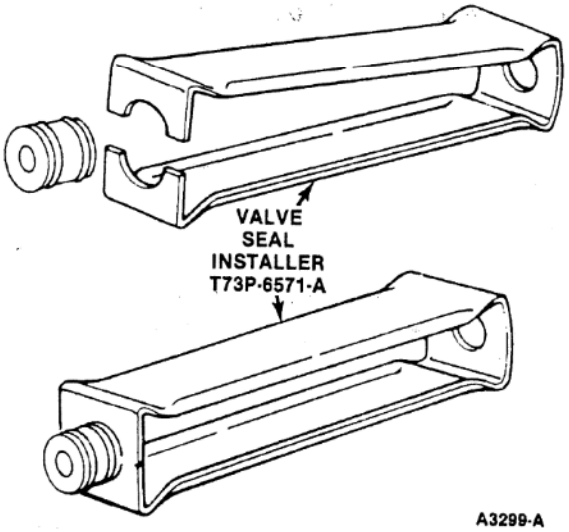


CLEANING, INSPECTION AND OVERHAUL

CYLINDER HEAD

Camshaft Bearings Installation (Continued)

Using Valve Seal Installer T73P-6571-A, or equivalent, force the seal onto the valve guide until it bottoms.



Assemble the valve springs and seat, the spring retainers and the valve key locks. Using a horseshoe type of valve spring compressor, compress the valve spring and install the valve key locks. Be sure the spring retainer is up onto the locks and the locks are seated on the valve stem grooves. Repeat above for all valves. Measure the valve spring installed height. Any assemblies that are too high must be disassembled and a shim placed between the valve spring seat and the cylinder head. The shims are available in .762- and 1.524-mm (.030- and .060-in.) thicknesses.

Oil the camshaft bearing journals and lobes. Be sure the plug is fully bottomed in the rear of the camshaft.

Install the camshaft into the bearings. Be careful not to scratch the bearings with the camshaft lobes.

Install the camshaft thrust plate. Torque the screws to 8 to 12 N·m (6 to 9 lb-ft). Check the camshaft endplay. It should be .0254 to .2286 mm (.001 to .009 in.). Install the camshaft seal using Front Seals Replacer T74P-6150-A, or equivalent.

If, during cylinder head inspection, the hydraulic lash adjuster did not meet the leakdown test specification, it can be disassembled and cleaned.

Remove the retaining ring and the remaining parts. Clean in solvent and reassemble. Test the leakdown rate again. If its rate is out of specification, replace with a new lash adjuster. Test the new lash adjuster before installation.

Install the lash adjusters in the cylinder head. Support the cylinder head to prevent damage to the valves. Turn the camshaft so the camshaft lobe of the cam follower being installed is facing the cam follower. Using Valve Spring Compressor T74P-6565-A, or equivalent, compress the lash adjuster or the valve spring and slide the cam follower into position under the camshaft. Be sure the lash adjuster has been fully compressed before proceeding to the next cam lobe position.

Repeat follower installation until all followers are installed.

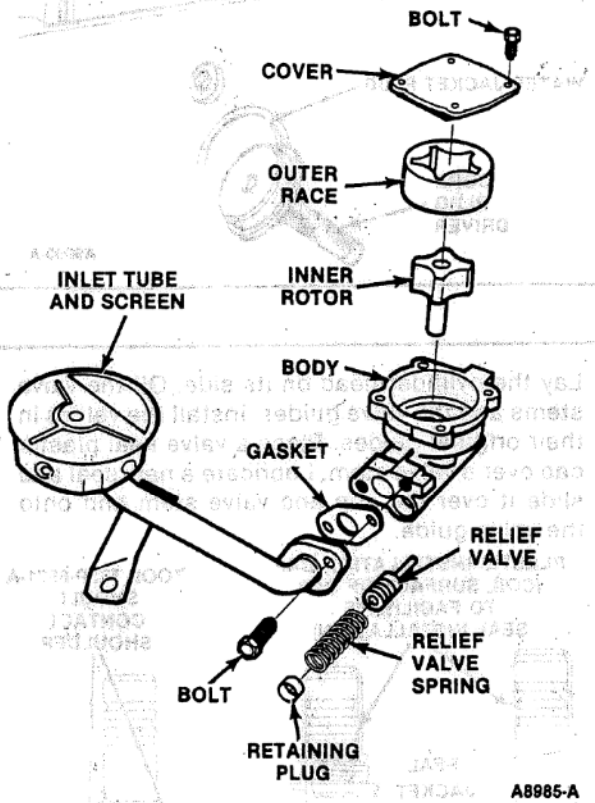
Install the camshaft drive belt spring tensioner spring stop stud. Install a new gasket and the coolant outlet elbow onto the cylinder head. For cylinder head installation, refer to Base Procedure 23—Assembly, Cylinder Head Installation.

CLEANING, INSPECTION AND OVERHAUL

OIL PUMP

Disassembly

1. Remove the two bolts and the inlet tube and screen.
2. Remove four bolts and the oil pump cover.
3. Remove the inner rotor and outer race.
4. Drill or punch a hole in the oil pump relief valve retaining plug.
5. Insert a punch and pry the plug out.
6. Remove the spring and valve.

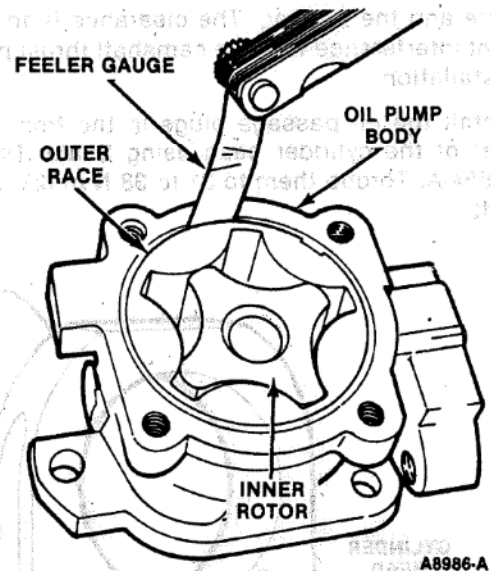


Cleaning

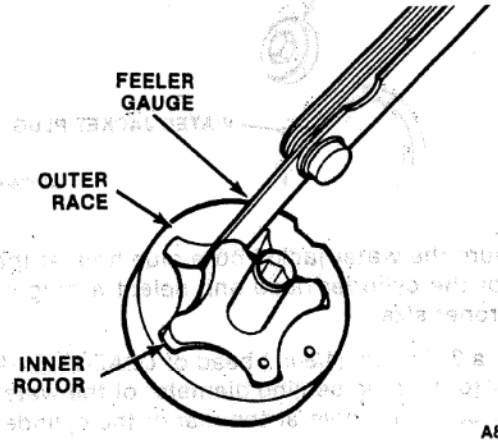
The oil pump may be cleaned with automotive parts cleaning solvent or steam cleaned. Do not clean with caustic or lye-based solutions. If the rotor and race are steam cleaned with a water solution, dry and oil after cleaning as they will rust. Do not drop the rotor or race on a hard surface. They are brittle and may break.

Inspection

Inspect the oil pump body for scoring in the outer race bore. If the scoring is light, then disregard. Measure the body (housing) to outer race clearance with a feeler gauge. The clearance should be .0254 to .3302 mm (.001 to .013 in.).



Measure the rotor tip to outer race clearance at the least clearance point with the rotor and race out of the body. The clearance should be .254 mm (.010 in.) maximum with the feeler gauge inserted 12.7 mm (1/2 in.).



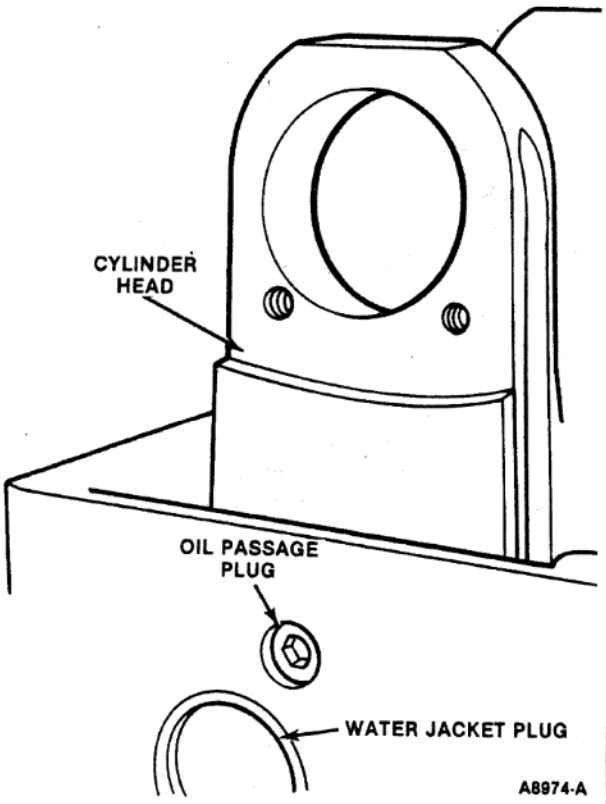
CLEANING, INSPECTION AND OVERHAUL

CYLINDER HEAD

Camshaft Bearing Installation (Continued)

On the rear bearing installation, care must be taken to allow .000- to .254-mm (.000- to .010-in.) clearance between the rear face of the bearing bore and the bearing. The clearance is to prevent interference with the camshaft thrust plate installation.

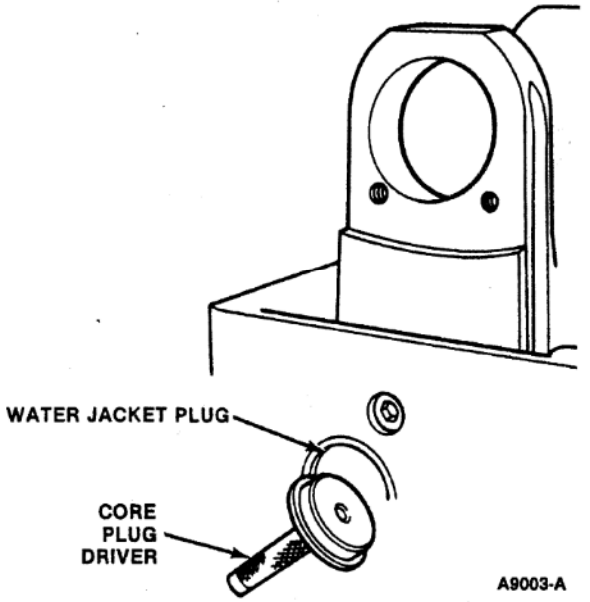
Install the oil passage plugs in the front and rear of the cylinder head using Sealer D8AZ-19554-A. Torque them to 31 to 38 N·m (23 to 28 lb-ft).



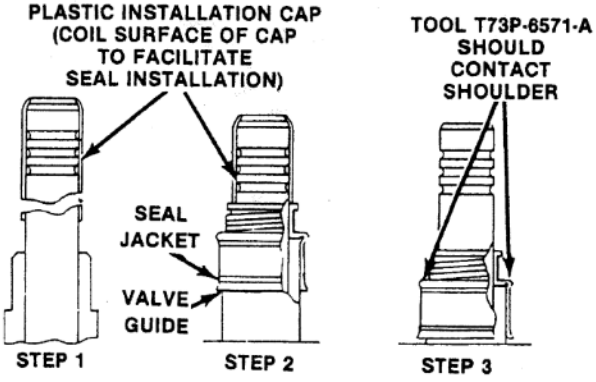
Measure the water jacket core plug hole at the rear of the cylinder head and select a plug of the proper size.

Apply a 3.175-mm (1/8-in.) bead of D8AZ-19554-A sealer to the plug sealing diameter of the water jacket core plug hole at the rear of the cylinder head.

Using a suitable driver, install the core plug in the cylinder head until it bottoms in the bore.



Lay the cylinder head on its side. Oil the valve stems and the valve guides. Install the valves in their original guides. Place a valve seal plastic cap over a valve stem. Lubricate a new seal and slide it over the cap and valve stem and onto the valve guide.



STEP #1— WITH VALVES IN HEAD, PLACE PLASTIC INSTALLATION CAP OVER END OF VALVE SYSTEM.

STEP #2— START VALVE STEM SEAL CAREFULLY OVER CAP. PUSH SEAL DOWN UNTIL JACKET TOUCHES TOP OF GUIDE.

STEP #3— REMOVE PLASTIC INSTALLATION CAP. USE INSTALLATION TOOL T73P-6571-A OR SCREWDRIVERS TO BOTTOM SEAL ON VALVE GUIDE.

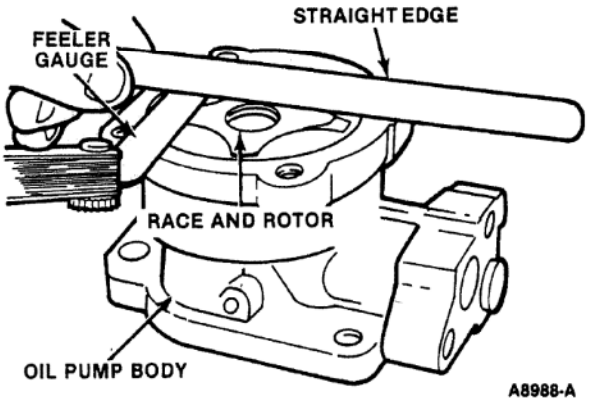
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CLEANING, INSPECTION AND OVERHAUL

OIL PUMP

Inspection (Continued)

Using a straightedge, measure the rotor and race endplay in the body. The dimension should be .1016 mm (.004 in.) maximum. Measure the rotor shaft to shaft bearing bore clearance. The specification is .0381 to .0762 mm (.0015 to .0030 in.).



The relief valve to valve bore clearance should be .0381 to .0762 mm (.0015 to .0030 in.). Check the relief valve spring tension. Its length should be 30.48 mm (1.20 in.) with a 6.8947- to 7.8019-kg (15.2- to 17.2-lb) load.

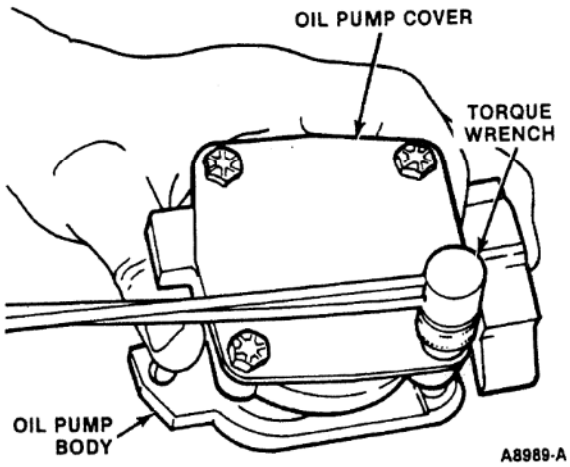
Overhaul

Internal parts of the oil pump are not serviced. If any of the dimensions under Oil Pump Inspection are exceeded, the oil pump assembly must be replaced.

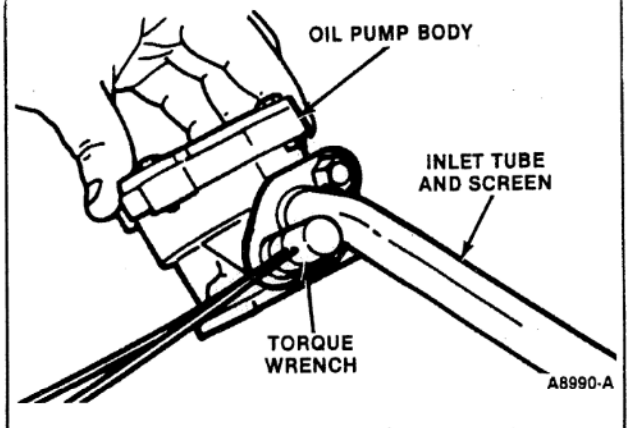
Assembly

Assemble the oil pump relief valve into its bore. Install the spring. Install a new plug with a bar or rod that is slightly smaller than the plug bore. Tap in until the plug bottoms in its bore.

Install the outer race and inner rotor in the pump body. Install the body cover. Torque the cover bolts to 10 to 15 N·m (90 to 130 lb-in.).



Using a new gasket, install the inlet tube and screen. Start the bolts and torque them to 19 to 28 N·m (14 to 21 lb-ft).



SECTION 21-29 Electronic Engine Control System (EEC)

SUBJECT	PAGE
COMPONENT LOCATOR	
Engine Compartment	21-29-1
Passenger Compartment	21-29-5
GENERAL INFORMATION	21-29-1

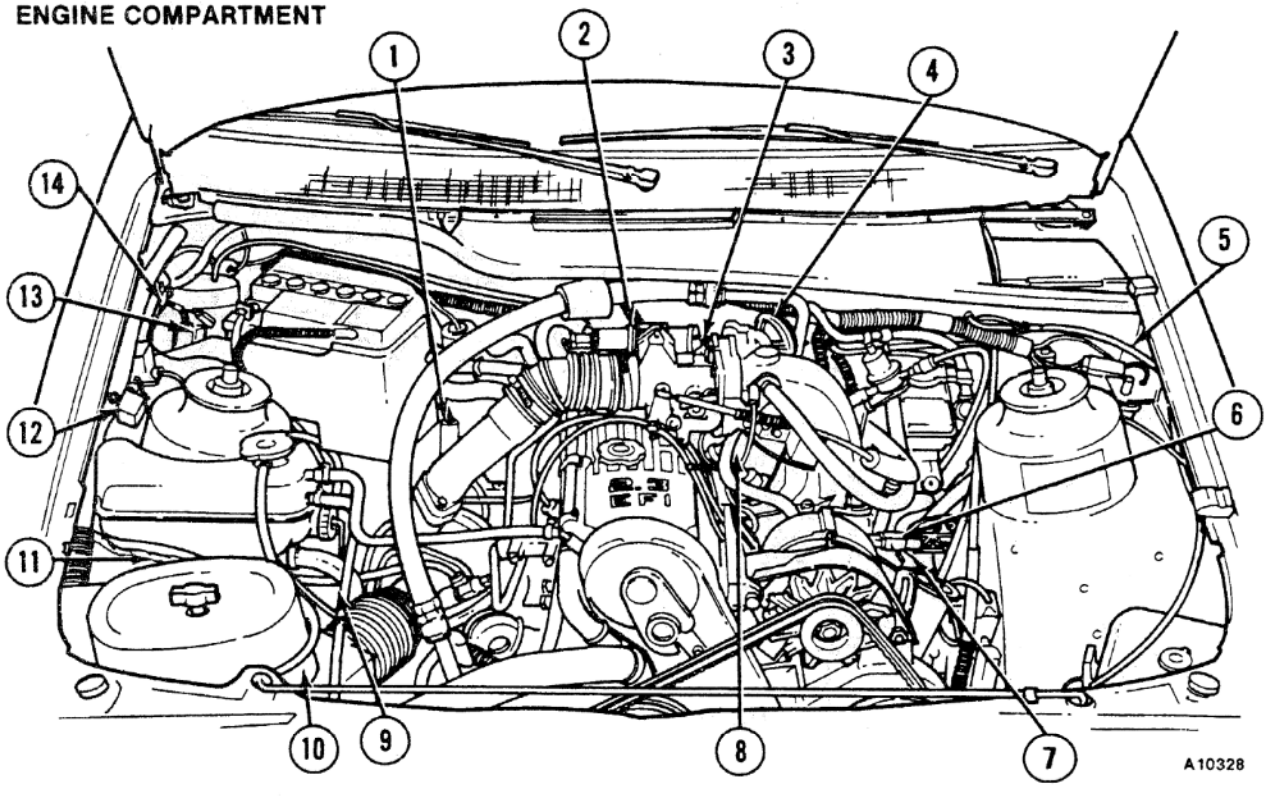
GENERAL INFORMATION

The purpose of this section is to show the location of the components related to the Electronic Engine Control (EEC) system. Descriptions and diagnostic procedures for the EEC system and components are found in Group H located at the back of this Shop Manual.

COMPONENT LOCATOR

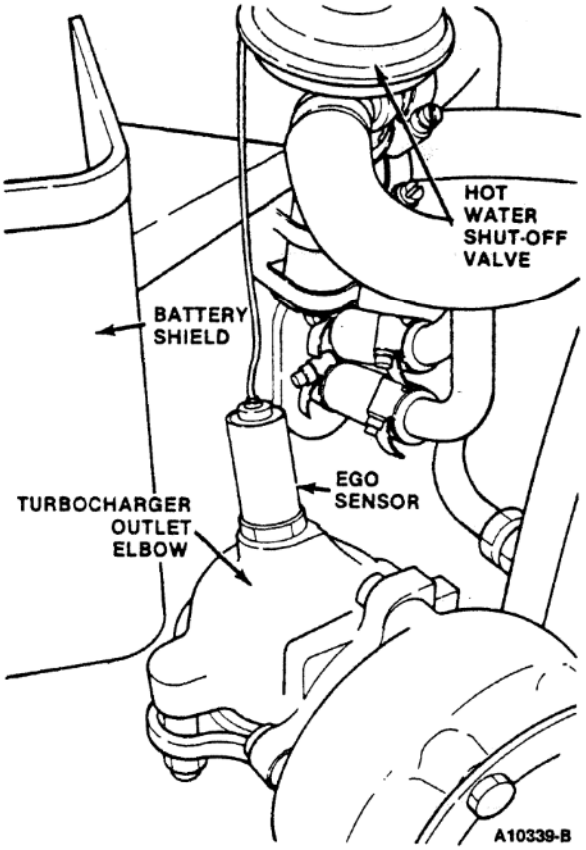
Engine Compartment

ENGINE COMPARTMENT

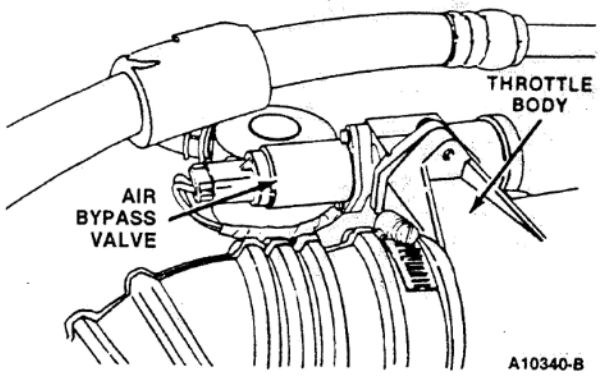


COMPONENT LOCATOR (Continued)

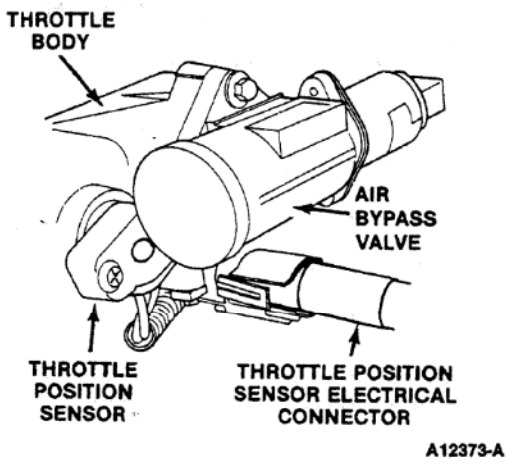
① Exhaust Gas Oxygen Sensor (EGO)



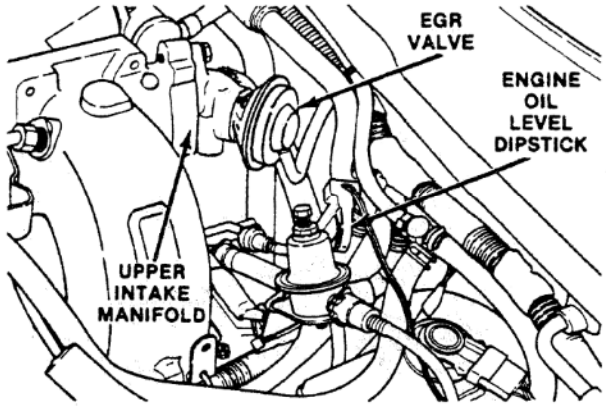
② Air Bypass Valve



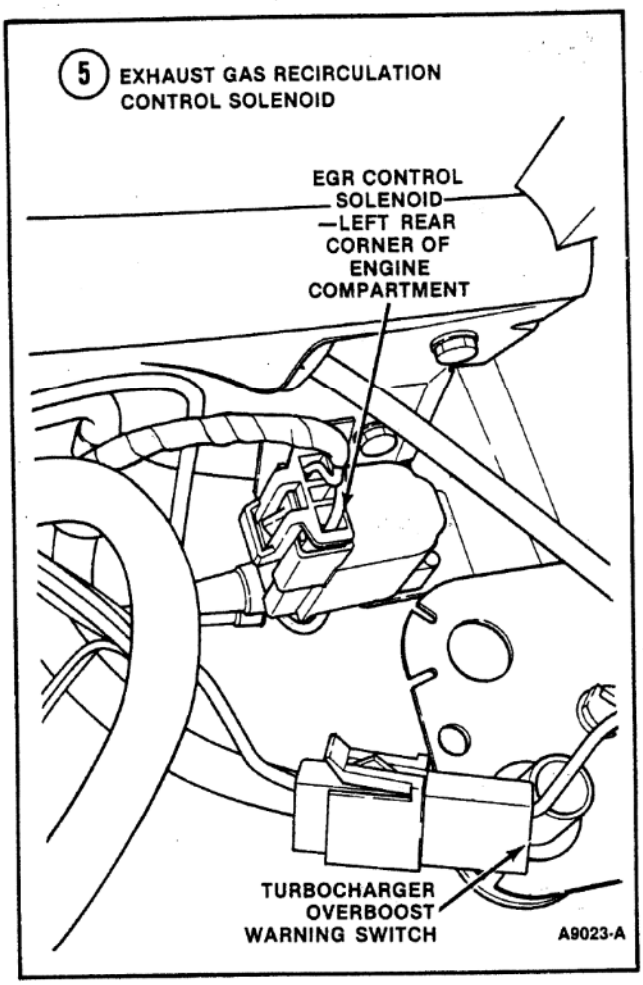
③ Throttle Position Sensor (TPS)

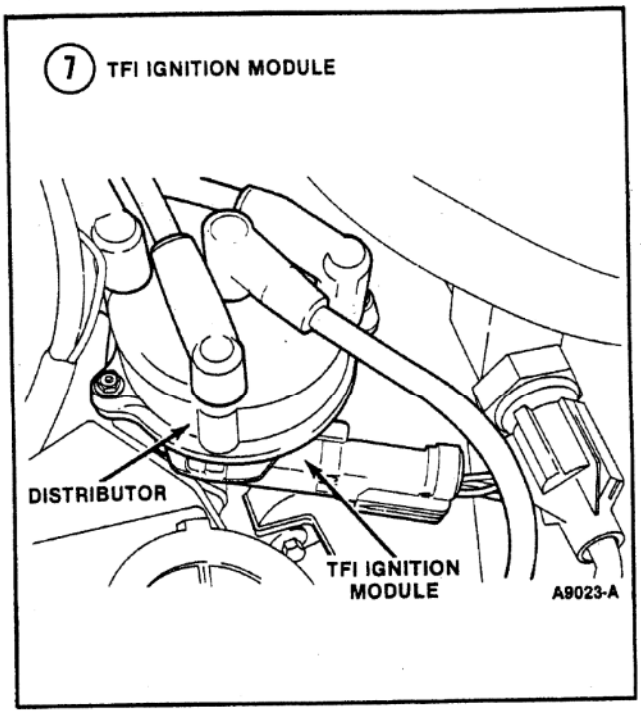


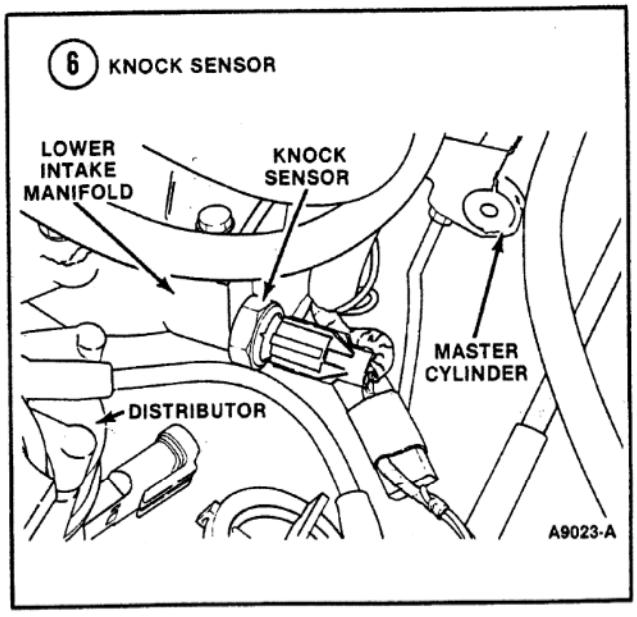
④ Exhaust Gas Recirculation Valve (EGR)

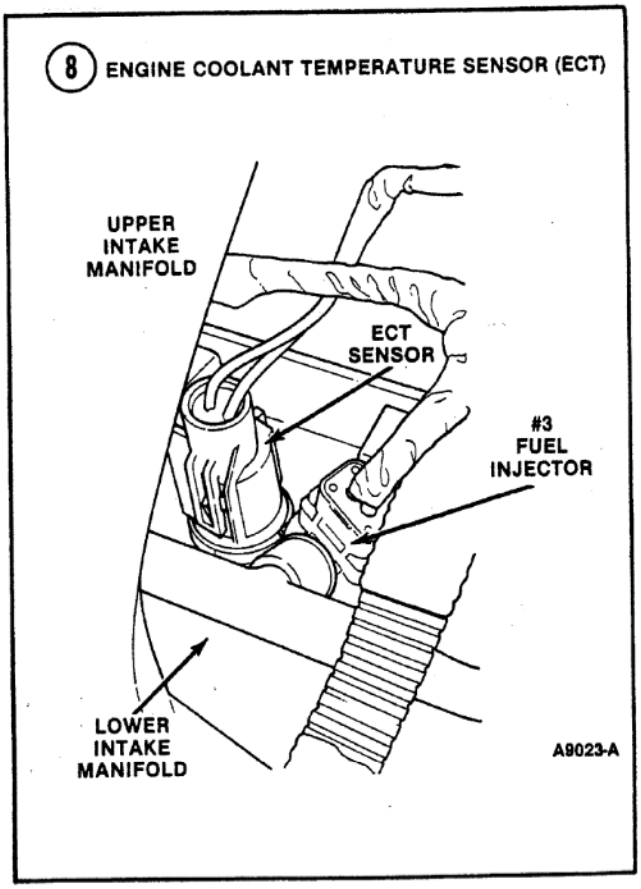


COMPONENT LOCATOR



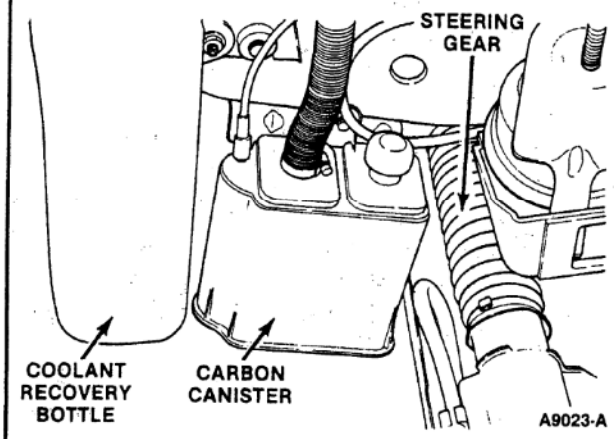




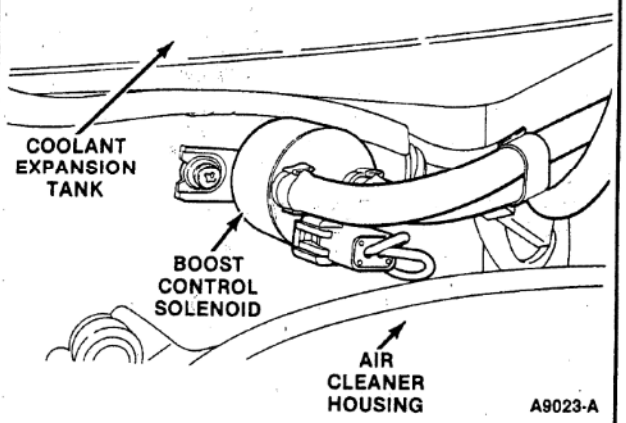


COMPONENT LOCATOR

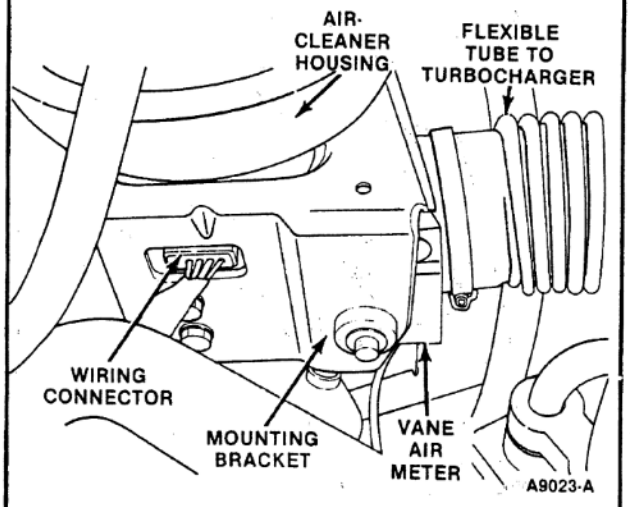
(9) CARBON CANISTER



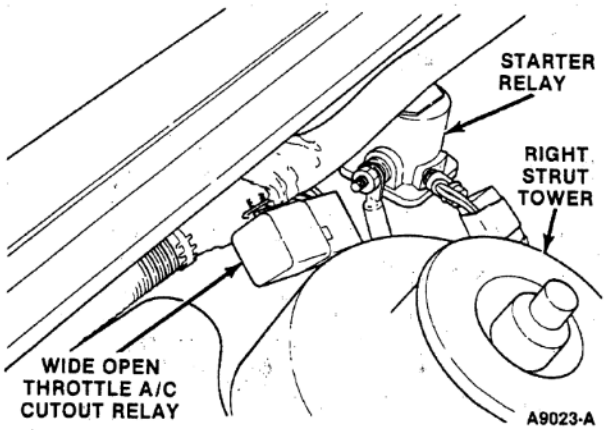
(11) TURBOCHARGER BOOST CONTROL SOLENOID



(10) VANE AIR METER/AIR CHARGE TEMPERATURE SENSOR

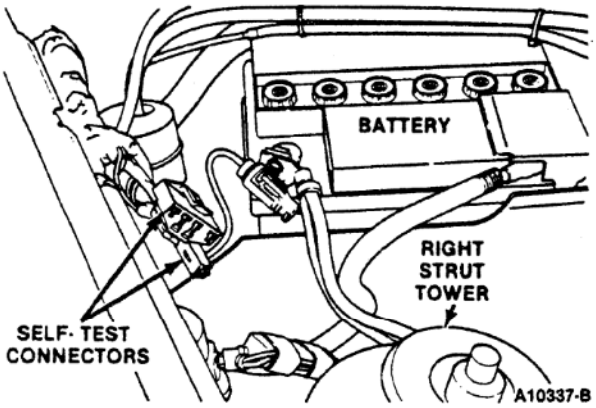


(12) WIDE OPEN THROTTLE A/C CUTOUT RELAY

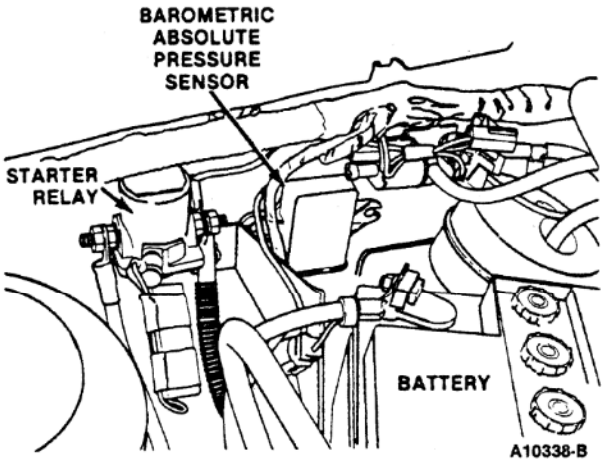


COMPONENT LOCATOR (Continued)

⑬ ECA Self-Test Connectors

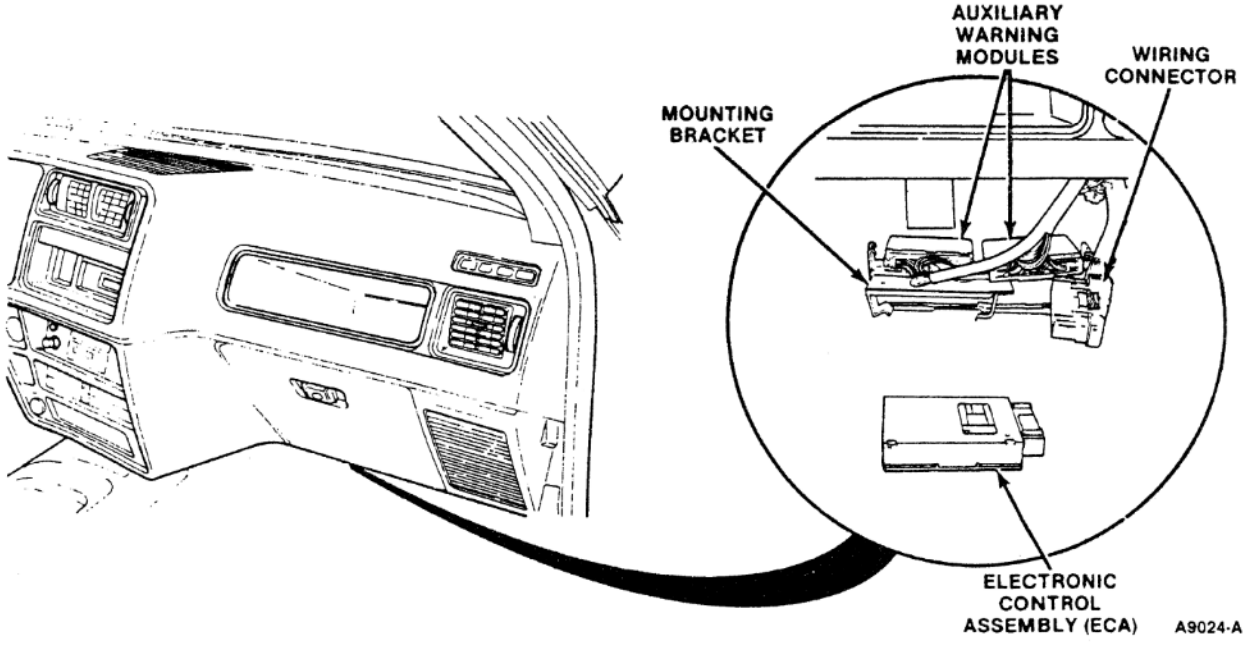


⑭ Barometric Absolute Pressure Sensor (BAP)

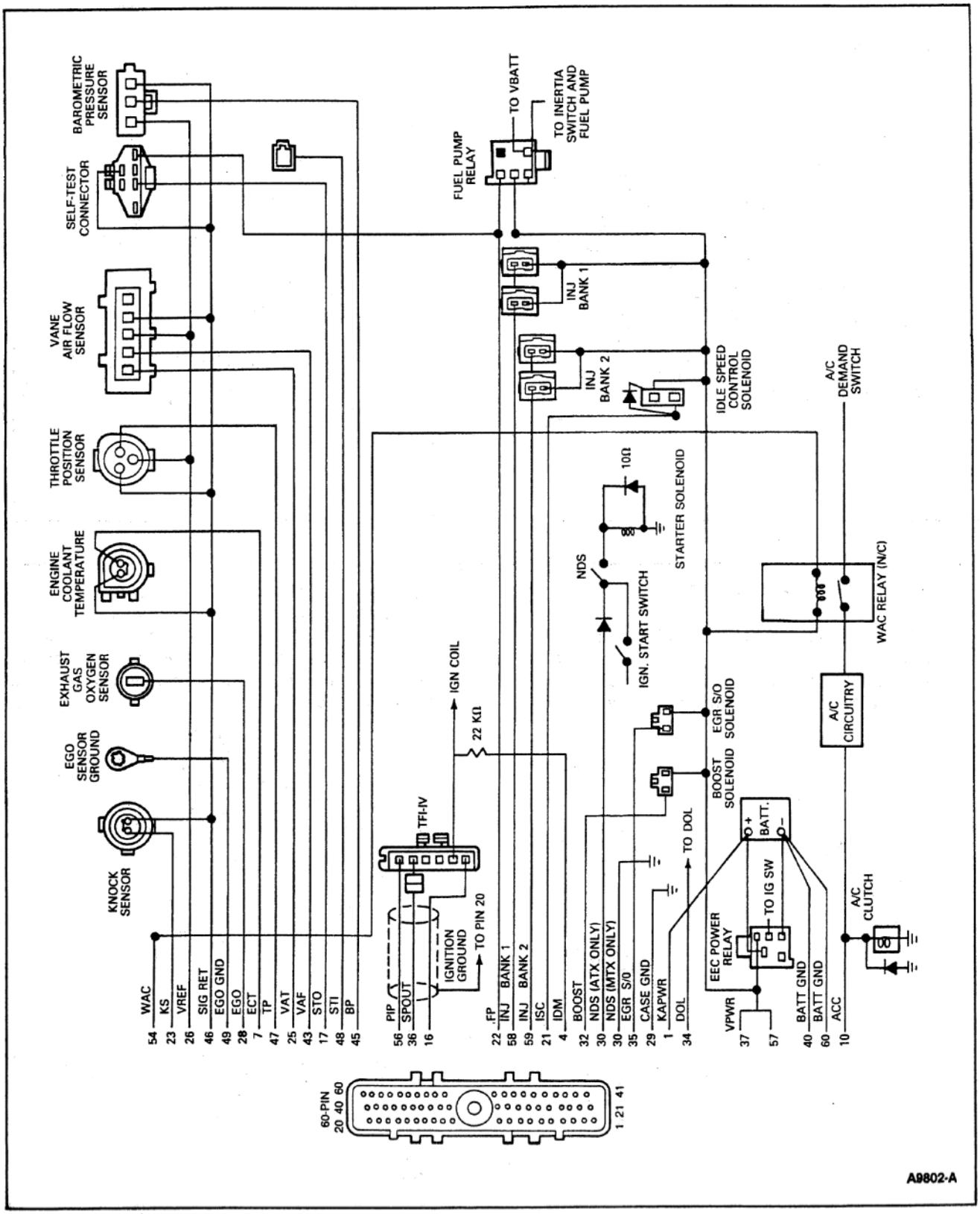


Passenger Compartment

The Electronic Control Assembly (ECA) is located behind the lower instrument panel on the passenger side of the vehicle. Access is gained to the ECA wiring connector by removing a sound-deadening panel attached to the bottom of the instrument panel. A screw through the center of the wiring connector attaches the wiring harness to the ECA. The screw can be loosened and the connector separated without removing the ECA from its mounting bracket.



ELECTRICAL SCHEMATIC

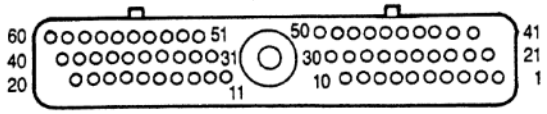


SUPPLEMENT 1

ECA PINOUT DESCRIPTION

Pin	Circuit	Wire Color	Application	Abbreviations
1	37	Y	Keep Alive Memory	KAM
4	11	DG-Y D	Ignition Diagnostic Monitor	IDM
7	354	LG/Y	Engine Coolant Temperature	ECT
10	347	BK-Y H	A/C Clutch	ACC
16	259	R-O H	Ignition Ground	IGN GND
17	201	T-R	Self-Test Output	STO
20	57	BK	Case Ground	CSE GND
21	67	GY-W H	Idle Speed Control	ISC
22	97	T-LG D	Fuel Pump Control	FP
23	310	Y-R D	Knock Sensor	KS
25	357	LG-P	Vane Air Temperature	VAT
26	351	O-W	Voltage Reference	V. REF.
29	94	DG-P H	Exhaust Gas Oxygen Sensor	EGO
30	376	Y-LG D	Neutral Drive Switch	NDS
32	544	P	Boost Control	BOOST
34	139	LG-P	Data Output Link	DOL
35	362	Y	EGR Shut-Off	EGR S/O
36	324	Y-LG D	Spark Output	SPOUT
37	361	R	Vehicle Power	V PWR
40	57	BK	Battery Control	BATT. GND
43	200	W-BK	Vane Air Flow	VAF
45	358	LG-BK	Barometric Pressure	BP
46	359	BK-W	Signal Return	SIG RET
47	355	DG-LG	Throttle Position Sensor	T.P.
48	100	W-R D	Self-Test Input	STI
49	89	O	EGO Ground	EGO GND
54	208	GY-BK D	W.O.T. A/C Cut-Off	WAC
56	349	DB	Profile Ignition Pick-Up	PIP
57	361	R	Vehicle Power	V PWR
58	95	T-R D	Injector Bank 1	INJ 1
59	96	T-O D	Injector Bank 2	INJ 2
60	57	BK	Battery Ground	BATT. GND

Pin locations given for reference only. Probing 60 pin connector with DVOM probe will result in permanent damage to the pin connectors. Always probe as directed, using the Breakout Box.



A9801-A

Group 21 Specifications

GENERAL SPECIFICATIONS	
DISPLACEMENT	2.3L
NUMBERS OF CYLINDERS	4
BORE AND STROKE	3.780 x 3.126
FIRING ORDER	1-3-4-2
OIL PRESSURE (HOT @ 2000 RPM)	40-60
DRIVE BELT TENSION	Refer to Section 27-02
CYLINDER HEAD AND VALVE TRAIN	
COMBUSTION CHAMBER VOLUME (cc)	59.55-62.55
VALVE GUIDE BORE DIAMETER	0.3433-0.3443
VALVE SEATS	
Width—Intake	.060-.080
Width—Exhaust	.070-.090
Angle	45°
RUNOUT LIMIT (T.I.R. MAX.)	0.0016
VALVE ARRANGEMENT (Front to Rear)	E-I-E-I-E-I-E-I
VALVE LASH ADJUSTER BORE	
DIAMETER	0.8430-0.9449
VALVE STEM TO GUIDE CLEARANCE	
Intake	0.0010-0.0027
Exhaust	0.0015-0.0032
Service Clearance Limit	0.0055 Max.
VALVE HEAD DIAMETER	
Intake	1.730-1.740
Exhaust	1.49-1.51
VALVE FACE RUNOUT LIMIT	0.002 Max.
VALVE FACE ANGLE LIMIT	44°
VALVE STEM DIAMETER (STANDARD)	
Intake	.3416-.3423
Exhaust	.3411-.3418
(0.015 Oversize)	
Intake	.3566-.3573
Exhaust	.3561-.3568
(0.030 Oversize)	
Intake	.3716-.3723
Exhaust	.3711-.3718
VALVE SPRINGS	
Compression Pressure (Lb. @ Spec. Length)	
Intake and Exhaust (Installed Load)	71-79 @ 1.52
Exhaust and Intake Valve	
(Open Load)	1.52-1.56 @ 1.52
Free Length (Approximate)	1.877
Assembled Height	1-17/32"-1-19/32"
Service Limit	5% Pressure Loss @ Specified Length
Out-of-Square Service Limit	5/64 (0.078)
ROCKER ARM (Cam Follower)	
Ratio	1.4-1.6:1
VALVE TAPPET, LIFTER OR ADJUSTER	
Diameter (Standard)	0.8422-0.8427
Clearance-to-Bore	0.0007-0.0027
Service Limit	0.005 Max.
Hydraulic Leakdown Rate (1)	2-8 Seconds
Collapsed Tappet Gap	
Allowable	0.035-0.055 @ Cam
Desired	0.040-0.050 @ Cam

CAMSHAFT	
LOBE LIFT	
Intake	.400
Exhaust	.400
Allowable Lobe Lift Loss	0.005 Max.
THEORETICAL VALVE LIFT @ ZERO LASH	
Intake	.390
Exhaust	.390
ENDPLAY	0.001-0.007
Service Limit	0.009
JOURNAL-TO-BEARING CLEARANCE	0.001-0.003
Service Limit	0.006
JOURNAL DIAMETER	
#1	1.7713-1.7720
#2	1.7713-1.7720
#3	1.7713-1.7720
#4	1.7713-1.7720
Runout Limit	0.005 Max. T.I.R.
Out-of-Round Limit	0.0005 In. Max.
Front Bearing Location	(2) 0.000-0.010

CYLINDER BLOCK	
HEAD GASKET SURFACE	
FLATNESS	0.003 in any 6"-0.006 overall
HEAD GASKET SURFACE FINISH (RMS)	60-150
CYLINDER BORE	
Diameter	3.7795-3.7825
Surface Finish (CLA)	8-24
Out-of-Round Limit	0.0015
Out-of-Round Service Limit	0.005
Taper Service Limit	0.010
MAIN BEARING BORE DIAMETER	2.5902-2.5910
DISTRIBUTOR SHAFT BEARING	
BORE DIAMETER	.5155-.5170

CRANKSHAFT, FLYWHEEL AND CONNECTING ROD	
MAIN BEARING JOURNAL DIAMETER	2.399-2.3982
Out-of-Round Limit	0.0006 Max.
Taper Limit	0.0006 Per Inch
Journal Runout Limit	0.002 Max.
Surface Finish (RMS)	12 Max.
Runout Service Limit	0.005
THRUST BEARING JOURNAL	
Length	1.2010-1.1990
CONNECTING ROD JOURNAL	
Diameter	2.0465-2.0472
Out-of-Round Limit	0.0006 Max.
Taper Limit	0.0006 Per Inch Max.
Surface Finish (RMS)	12 Max.
MAIN BEARING THRUST FACE	
Surface Finish (RMS)	35 Front 25 Rear (Max.)
Runout Limit	0.001 Max.
FLYWHEEL CLUTCH FACE	
Runout Limit	0.005
FLYWHEEL RING GEAR LATERAL RUNOUT (T.I.R.)	
Standard Transmission	0.025
Automatic Transmission	0.060
CRANKSHAFT FREE ENDPLAY LIMIT	0.004-0.008
Service Limit	0.012
AUXILIARY SHAFT ENDPLAY	0.001-0.007
CONNECTING ROD BEARINGS	
Clearance Crankshaft—Desired	0.0008-0.0015
—Allowable	0.0008-0.0026

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CRANKSHAFT, FLYWHEEL AND CONNECTING ROD (Cont'd.)

Bearing Wall Thickness (Standard) (3)	0.0619–0.0624
MAIN BEARINGS	
Clearance to Crankshaft—Desired	0.0008–0.0015
—Allowable	0.0008–0.0026
Bearing Wall Thickness (Standard) (3)	0.0956–0.0951
AUXILIARY SHAFT BEARINGS	
Clearance to Shaft	0.0006–0.0026
CONNECTING ROD	
Piston Pin Bore Diameter	.9096–.9012
Crankshaft Bearing Bore Diameter	2.1720–2.1728
Out-of-Round Limit	0.0004
Taper Limit	0.0004
Length (Center-to-Center)	5.2031–5.2063
Alignment (Bore-to-Bore Max. Difference) (4)	
Twist	0.024
Bend	0.012
Side Clearance (Assembled to Crank)	
Standard	0.0035–0.0105
Service Limit	0.014

PISTONS AND RINGS

PISTON	
Diameter (5)	
Coded Red	3.7764–3.7770
Coded Blue	3.7776–3.7782
0.003 Oversize	3.7788–3.7794
Piston-to-Bore Clearance (Select Fit)	0.0030–0.0038
Pin Bore Diameter	0.9123–0.9126
Ring Groove Width	
Compression (Top)	0.080–0.081
Compression (Bottom)	0.080–0.081
Oil	0.188–0.189
PISTON PIN	
Length	3.010–3.040
Diameter	
Standard	0.9118–0.9124
0.001 Oversize	0.9130–0.9133
0.002 Oversize	0.9140–0.9143
Piston-to-Pin Clearance	.0003–.0005
Pin-to-Rod Clearance	Interference Fit
PISTON RINGS	
Ring Width	
Compression (Top)	0.077–0.078
Compression (Bottom)	0.077–0.078
Side Clearance	
Compression (Top)	0.002–0.004
Compression (Bottom)	0.002–0.004
Oil Ring	Snug Fit
Service Limit	0.006 Max.
Ring Gap	
Compression (Top)	0.010–0.020
Compression (Bottom)	0.010–0.020
Oil (Steel Rail)	0.015–0.055

LUBRICATION SYSTEM

OIL PUMP	
Relief Valve Spring Tension (Lbs. Spec. Length)	15.2–17.2 @ 1.20"
Drive Shaft-to-Housing Bearing Clearance	0.0015–0.0030
Relief Valve-to-Bore Clearance	0.0015–0.0030
Rotor Assembly End Clearance (Assembled)	0.004 Max.
Outer Race-to-Housing Clearance	0.001–0.013
Oil Capacity (Quarts U.S.)	5.0

FUEL PUMP—Refer to Group 24 Specifications

TORQUE SPECIFICATIONS

ITEM	SIZE	N·m	LB-FT
AUXILIARY SHAFT GEAR BOLT	M-10	38–54	28–40
AUXILIARY SHAFT THRUST PLATE BOLT	M-6	8–12	6–9
BELT TENSIONER (TIMING PIVOT BOLT)	M-10	38–54	28–40
BELT TENSIONER (TIMING ADJUSTING BOLT)	M-8	19–28	14–21
CAMSHAFT GEAR BOLT	M-12	68–96	50–71
CAMSHAFT THRUST PLATE BOLT	M-6	8–12	6–9
CONNECTING ROD NUT (7)	M-9	41–49	30–36
CRANKSHAFT DAMPER BOLT	M-14	136–162	100–120
CYLINDER HEAD BOLT (8)	M-12	108–122	80–90
DISTRIBUTOR CLAMP BOLT	M-10	19–28	14–21
EXHAUST MANIFOLD TO CYLINDER HEAD BOLT, STUD OR NUT (9)	M-10	22–31	16–23
FLYWHEEL TO CRANKSHAFT BOLT	M-10	73–87	56–64
INTAKE MANIFOLD TO CYLINDER HEAD BOLT NUT	M-8	19–28	14–21
MAIN BEARING CAP BOLT (10)	M-12	108–122	80–90
OIL PRESSURE SENDING UNIT TO BLOCK		11–24	8–18
OIL PUMP PICKUP TUBE TO PUMP	M-18	19–28	14–21
TURBO TO MANIFOLD NUT		38–54	28–40
NUT, OIL SUPPLY LINE		27–40	20–30
NUT, OIL SUPPLY LINE FITTING		12–16	9–12
BOLT, OIL RETURN TO TURBO		19–29	14–21
NUT, OIL RETURN TO FITTING		12–16	9–22
NUT, OIL RETURN FITTING TO UPPER BLOCK		8–12	6–9
BOLT—INTAKE MANIFOLD LOWER		19–29	14–21
NUT—THROTTLE BODY TO UPPER INTAKE		19–29	14–21
OIL PUMP TO BLOCK	M-8	19–28	14–21
OIL PUMP COVER		10–15	90–130
OIL PAN DRAIN PLUG TO PAN	M-14	21–33	15–25
OIL PAN TO BLOCK	M-6	7–11	6–8
	M-8	11–13	8–10
OIL FILTER INSERT TO CYLINDER BLOCK		28–33	20–25
OIL FILTER TO ENGINE	(11)		
ROCKER ARM COVER TO CYLINDER HEAD	M-6	7–11	5–8
SPARK PLUG TO CYLINDER HEAD	M-14	9–20	7–15
TEMPERATURE SENDING UNIT TO BLOCK		11–24	8–18

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TORQUE SPECIFICATIONS (Cont'd.)

WATER JACKET DRAIN PLUG TO BLOCK		32-37	23-28
WATER PUMP TO BLOCK BOLT	M-8	19-28	14-21
EGR VALVE TO MANIFOLD	M-8	19-28	14-21
EGR TUBE TO EXHAUST MANIFOLD CONN.		13-14	9-11
EGR TUBE NUT		13-14	9-11
AUXILIARY SHAFT COVER BOLT	M-6	8-12	6-9
WATER OUTLET CONNECTION BOLT	M-8	19-28	14-21
CYLINDER FRONT COVER BOLT	M-6	8-12	6-9
INNER TIMING BELT COVER STUD	M-8	19-28	14-21
OUTER TIMING BELT COVER BOLT	M-6	8-12	6-9
ROCKER ARM COVER SHIELD BOLT	M-10	38-54	28-40

NEW AND USED DRIVE BELT TENSION SPECIFICATIONS—Refer to Section 27-02

NOTE: "FIXED" refers to systems with manually adjusted centers which are bolted in place and considered fixed.

(1) Time required for plunger to leak down 1/8" of travel with 50 lb. load leakdown fluid in lash adjuster.
(2) Distance in inches that front bearing is installed below front face of bearing tower.
(3) 0.002 undersize = Add 0.001 to Standard Thickness.
(4) Pin bore and crank bearing bore must be parallel and in the same vertical plane, within the specified total difference when measured at the ends of an 8" bar—4" on each side of rod centerline.
(5) Measured at the piston pin bore, centerline—90° to the pin.
(6) Add one pint with filter change.
(7) Torque in sequence in two steps:
- Step 1—34-41 N·m (25-30 lb-ft)
- Step 2—41-49 N·m (30-36 lb-ft)

(8) Torque cylinder head bolts in sequence in two steps:
- Step 1—68-81 N·m (50-60 lb-ft)
- Step 2—108-122 N·m (80-90 lb-ft)

(9) Torque in sequence in two steps:
- Step 1—7-9 N·m (5-7 lb-ft)
- Step 2—22-31 N·m (16-23 lb-ft)

(10) Torque in sequence in two steps:
- Step 1—68-81 N·m (50-60 lb-ft)
- Step 2—108-122 N·m (80-90 lb-ft)

(11) 1/2 turn after gasket contacts surface—oil gasket.

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IGNITION SYSTEM

GROUP 23 (12000)

TITLE SECTION	PAGE NO.	TITLE SECTION	PAGE NO.

IGNITION SYSTEM DIAGNOSIS 23-01

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- Ignition System Troubleshooting Chart 3
- Engine Cranks But Will Not Start Diagnosis Chart 4

CIRCUIT WIRING DIAGRAM 9

DIAGNOSTIC PROCEDURES

- Base Timing Check/Adjustment 10
- Initial Timing Check 11
- Spark Plug Troubleshooting Chart 12
- Ignition Coil Tests 14
- Oscilloscope Checks 15
- Spark Plug Firing Order and Routing 19
- Component Inspection Chart 20

IGNITION SYSTEM 23-02

DESCRIPTION 1

REMOVAL AND INSTALLATION

- Distributor Assembly 2
- TFI-IV Ignition Module 4
- Distributor Cap and Rotor 6
- Spark Plug Wires 7
- Spark Plug 9
- Octane Rod 11

DISASSEMBLY AND ASSEMBLY

- Distributor 12

GROUP 23

SPECIFICATIONS 1

SECTION 23-01 IGNITION SYSTEM DIAGNOSIS

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GENERAL INFORMATION 1

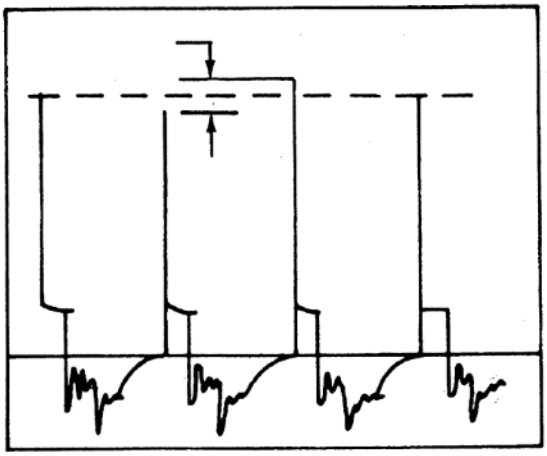
DIAGNOSTIC CHARTS

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- Component Inspection Chart 20



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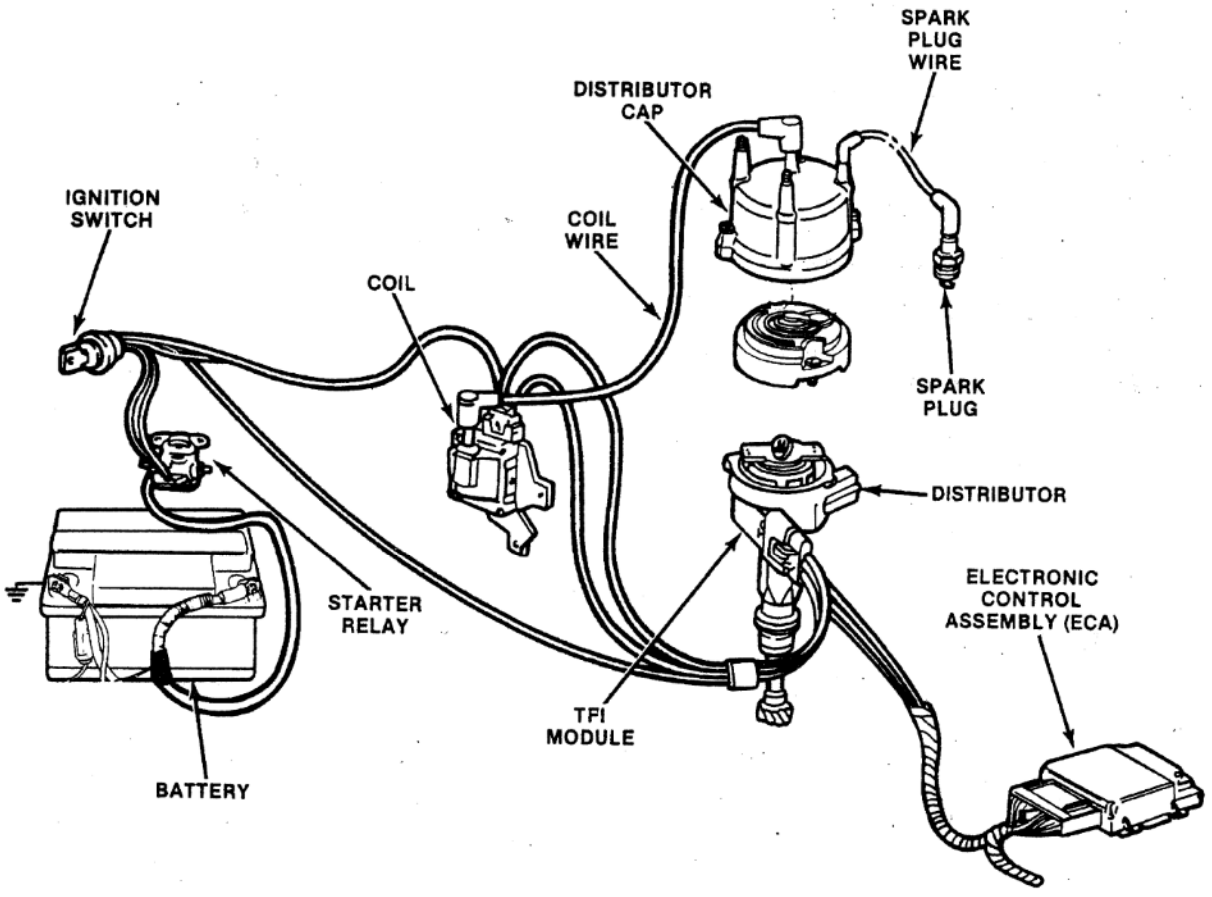
GENERAL INFORMATION

The engine ignition system circuitry has three distinct branches. Two of these branches—the secondary ignition and ignition coil primary circuits—are basically unchanged when compared to the now unused breaker point ignition system. It is the electronic replacement of the breaker points that forms the third branch of the ignition system.

In the EEC-IV ignition system, an electronic ignition module controls spark output and timing. The module is only part of a larger electronic engine control system that is monitored and directed by a micro-processor called the Electronic Control Assembly or ECA.

GENERAL INFORMATION

In this diagnostic section, the secondary and ignition coil primary branches will be covered. The remaining electronic branch is covered in the 1985 Car Shop Manual, Volume H—Emission Diagnosis and Engine Electronics. During diagnostic procedures and in the diagnosis charts, the coil primary circuit will cross over into the electronic circuits. Where this occurs, reference to the Engine/Emissions Shop Manual will be made.



DIAGNOSTIC CHARTS

IGNITION SYSTEM TROUBLESHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
ENGINE BACKFIRES BUT FAILS TO START	• Incorrect ignition timing	• Check base and initial timing. If necessary, refer to the Diagnostic Procedures in this section.
	• Moisture in distributor cap	• Clean and inspect distributor cap.
	• Distributor cap faulty	• Inspect distributor cap. If necessary, refer to the Component Inspection Chart in this section.
	• Spark plug wires not connected in correct firing order	• Check firing order and spark plug wire routing. If necessary, refer to the Diagnostic Procedures in this section.
ENGINE RUNS ONLY WITH KEY IN START POSITION	• Air leak past vane air meter	• Inspect flexible tubes for proper installation or damage.
MISFIRING (This condition can be more easily diagnosed using an oscilloscope. If necessary, refer to the Diagnostic Procedures in this section.)	• Faulty spark plugs	• Remove and inspect spark plugs. If necessary, refer to the Spark Plug Troubleshooting Chart.
	• Spark plug wire routing	• Check for proper firing order and routing. If necessary, refer to the Diagnostic Procedures in this section.
	• Breakdown in insulation of spark plug wire	• Check condition of spark plug wires. If necessary, refer to the Component Inspection Chart in this section.
	• Distributor cap damaged	• Inspect distributor cap. If necessary, refer to the Component Inspection Chart in this section.

DIAGNOSTIC CHARTS

IGNITION SYSTEM TROUBLESHOOTING CHART (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
MISFIRING (Cont'd)	• Gap between rotor and distributor terminals burned too wide	• Inspect rotor and cap for excessive erosion of terminals. If necessary, refer to the Component Inspection Chart in this section.
	• Incorrect ignition timing	• Check base timing. If necessary, refer to the Diagnostic Procedure in this section.

ENGINE CRANKS BUT WILL NOT START DIAGNOSIS CHART

1 EFI FUEL SYSTEM CHECK

TEST STEP	RESULT	ACTION TO TAKE
Turn ignition key to RUN position and listen for high-pressure pump to "buzz-up" to EFI system operating pressure.	High-pressure pump operates	Test Result OK. Proceed to 2.
	High-pressure pump does not operate	Proceed to Section 24-01, Fuel System Diagnosis.

2 ELECTRICAL CONNECTION CHECK

TEST STEP	RESULT	ACTION TO TAKE
Check electrical connections at ignition coil, distributor cap, spark plugs and TFI module.	All connections clean and tight	Test results OK. Proceed to 3.
	Connection(s) require tightening or cleaning	Test result not OK. Clean and tighten connections. Try to start engine. If engine does not start, proceed to 3.

DIAGNOSTIC CHARTS

ENGINE CRANKS BUT WILL NOT START DIAGNOSIS CHART (Continued)

3 SPARK OUTPUT CHECK

TEST STEP	RESULT	ACTION TO TAKE
• Connect remote starter switch. • Disconnect ignition coil wire from distributor. • Connect spark tester between ignition coil wire and ground. • Turn ignition key to RUN position. Crank engine using remote starter switch and check for spark.	Sparks at tester	Test result OK. Proceed to 5.
	No sparks at tester	Remove distributor cap and crank engine to verify distributor shaft is turning. • If distributor shaft does not turn, a problem exists in the distributor or auxiliary shaft drive. • If distributor shaft turns, proceed to 4.

4 COIL WIRE CHECK

TEST STEP	RESULT	ACTION TO TAKE
• Check ignition coil for proper connection at ignition coil. • Check ignition coil for excessive resistance or open. — Replace ignition coil wire if resistance exceeds 5,000 ohms per inch.	Ignition coil wire OK	Test results OK. Proceed to 11.
	Ignition coil wire not OK	Replace coil wire and attempt to start engine. If engine does not start, proceed to 11.

5 SPARK PLUG WIRE CHECK

TEST STEP	RESULT	ACTION TO TAKE
• Connect ignition coil wire to distributor. • Disconnect wire at any spark plug.	Sparks at tester	Remove and inspect spark plugs. If necessary, refer to the Spark Plug Inspection Chart in this section. If spark plugs are OK, proceed to 10.
• Connect spark tester between the spark plug wire and ground. • Turn ignition key to RUN position. Crank engine using remote starter switch and check for spark.	No sparks at tester	Test results OK. Proceed to 6.

DIAGNOSTIC CHARTS

ENGINE CRANKS BUT WILL NOT START DIAGNOSIS CHART (Continued)

6 DISTRIBUTOR CAP/ROTOR INSPECTION

TEST STEP	RESULT	ACTION TO TAKE
Check distributor cap and rotor for damage, carbon tracking or other conditions that might prevent engine starting. If necessary, refer to the Component Inspection Chart in this section.	Cap and rotor OK	Test Results OK. Proceed to 7.
	Cap and/or rotor not OK	Replace as necessary. Try to start engine. If engine does not start, proceed to 7.

7 SPARK PLUG WIRE CHECK

TEST STEP	RESULT	ACTION TO TAKE
Check resistance of spark plug wires and condition of insulation. If necessary, refer to the Component Inspection Chart in this section.	Less than 5,000 ohms per inch and insulation is in good condition	Test results OK. Proceed to 8.
	More than 5,000 ohms per inch, or wires are in poor condition	Replace wires. Try to start engine. If engine does not start, proceed to 8.

8 SPARK PLUG FIRING ORDER

TEST STEP	RESULT	ACTION TO TAKE
Check spark plug wires for proper installation in distributor cap according to firing order. If necessary, refer to the Diagnostic Procedure in this section.	Firing order correct	Test results OK. Proceed to 9.
	Firing order not correct	Install wires in proper firing order. Try to start engine. If engine does not start, proceed to 9.

9 SPARK PLUG CONDITION CHECK

TEST STEP	RESULT	ACTION TO TAKE
Remove and inspect spark plugs. If necessary, refer to the Spark Plug Inspection Chart in this section.	Spark plugs OK	Test Results OK. Proceed to 10.
	Spark plugs not OK	Replace spark plugs and attempt to start engine. If engine does not start, proceed to 10.

DIAGNOSTIC CHARTS (Continued)

ENGINE CRANKS BUT WILL NOT START DIAGNOSIS CHART (Continued)

10 STATIC TIMING CHECK

TEST STEP	RESULT	ACTION TO TAKE
Check engine static timing. If necessary, refer to the procedure in this section.	Rotor tip aligns with #1 in distributor cap	Test results OK. Problem does not seem to be in ignition system secondary circuit. Refer to Sections 21-01 and 24-01 or Group H in this Shop Manual.
	Rotor tip does not align with #1 in distributor cap	Loosen distributor clamp hold down bolt and turn the distributor base to align the rotor and distributor. **NOTE:** If the rotor-to-distributor misalignment is excessive, camshaft timing should be checked. If necessary, refer to Section 21-05.

11 TFI MODULE SWITCHING CIRCUIT CHECK

TEST STEP	RESULT	ACTION TO TAKE
• Attach a 12-volt DC test light between the ignition coil negative terminal (−) and engine ground. • Connect a remote starter switch. • Turn the ignition switch to the RUN position. • Crank engine and observe test light.	Light flashes	Test results OK. Proceed to 13.
	Light but no flash	Problem seems to be in ECA-related circuits. Refer to Group H located at the back of this Shop Manual.
	No light or very dim light	Proceed to 12.

12 COIL FEED CIRCUIT CHECK

TEST STEP	RESULT	ACTION TO TAKE
• Attach a 12-volt DC test light between the ignition coil positive terminal (+) and an engine ground. • Turn the ignition switch to the RUN position.	Light on	Proceed to 13.
	No light	Repair open in circuit 16—ignition coil feed. Attempt to start engine. If engine will not start, problem seems to be in ECA-related circuits. Refer to Group H located at the back of this Shop Manual.

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DIAGNOSTIC CHARTS (Continued)

ENGINE CRANKS BUT WILL NOT START DIAGNOSIS CHART (Continued)

13 IGNITION COIL TEST

TEST STEP	RESULT	ACTION TO TAKE
Perform coil primary and secondary resistance checks. If necessary, refer to the procedure in this section.	Coil resistance within specification	Problem seems to be in ECA-related circuits. Refer to Group H located at the back of this Shop Manual.
	Coil resistance not within specification	Replace coil. Attempt to start engine. If engine will not start, problem seems to be in ECA-related circuits. Refer to Group H located at the back of this Shop Manual.

14 TFI MODULE RUN CIRCUIT CHECK

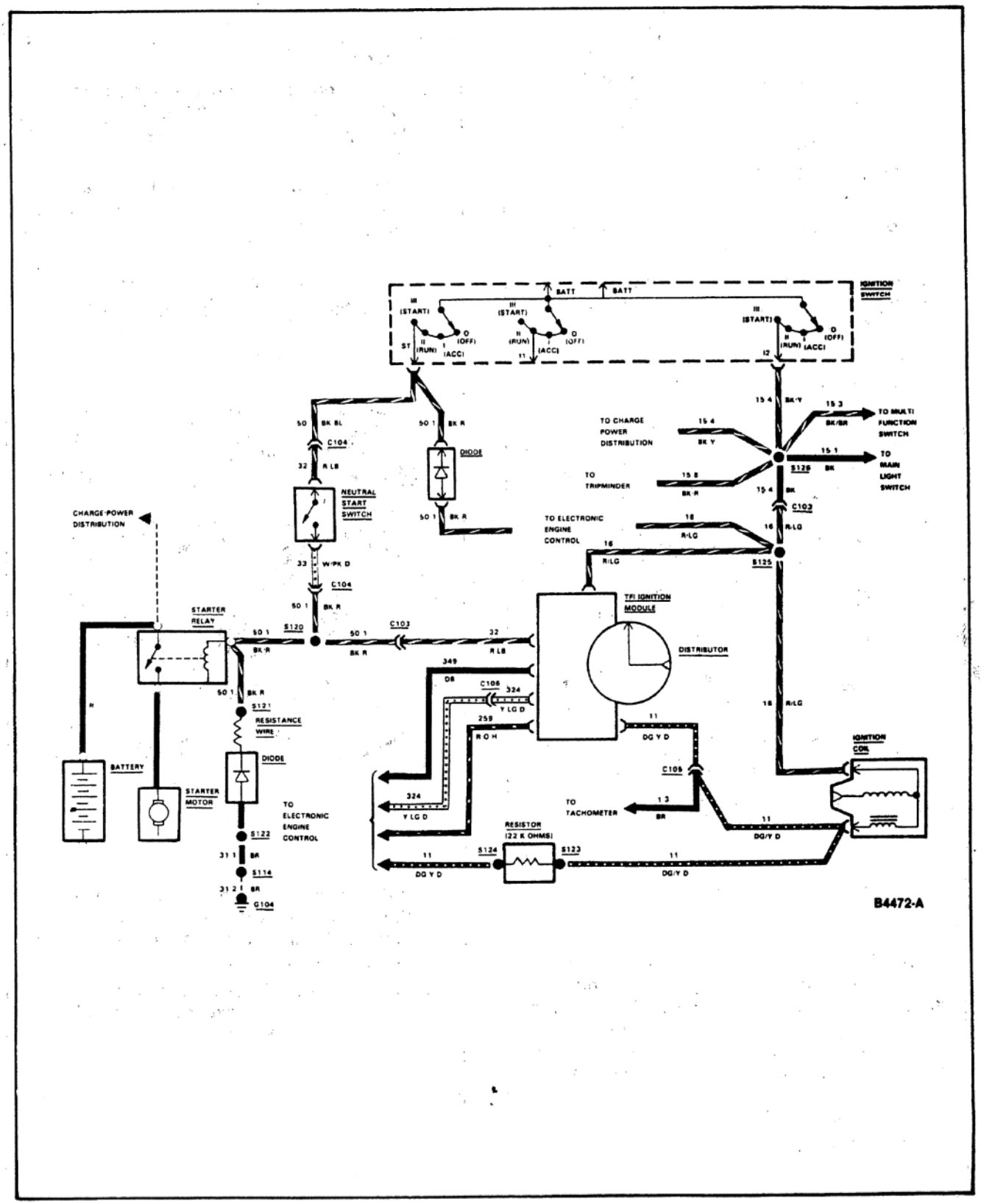
TEST STEP	RESULT	ACTION TO TAKE
• Disconnect wiring at distributor TFI ignition module. Attach a 12-volt DC test light between module connector wire 16 (R/LG) and ground. • Turn ignition key to RUN position and observe the test light.	No light	Repair open in TFI module circuit 16. Attempt to start engine. If engine will not start, problem seems to be in ECA-related circuits. Refer to Group H located at the back of this Shop Manual.
	Light on	Test results OK. Proceed to 15.

15 TFI MODULE CRANKING CIRCUIT CHECK

TEST STEP	RESULT	ACTION TO TAKE
• Disconnect wiring at distributor TFI ignition module. • Attach a 12-volt DC test light between module connector wire 32 (R/LB) and ground.	Light on	Test results OK. Problem seems to be in ECA-related circuits. Refer to Group H located at the back of this Shop Manual.
• Turn the ignition key to crank position and observe the test light.	Light off	Repair open in circuit 32. Attempt to start engine. If engine will not start, problem seems to be in ECA-related circuits. Refer to Group H located at the back of this Shop Manual.

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CIRCUIT WIRING DIAGRAM



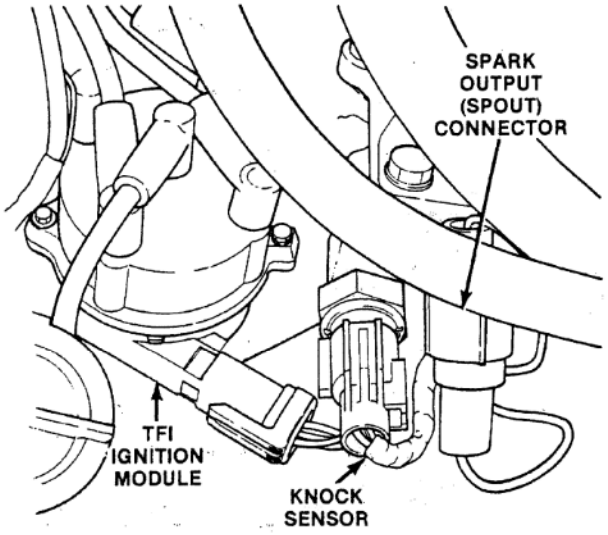
DIAGNOSTIC PROCEDURES

BASE TIMING CHECK/ADJUSTMENT

1. Position the transmission selector lever in Park (automatic transmission) or Neutral (manual transmission) and firmly set the parking brake.
2. Make sure the A/C control is in the OFF position.
3. Connect an inductive timing light and a tachometer.

NOTE: The ignition coil connector allows a tachometer connection using an alligator clip without removing the coil connector.

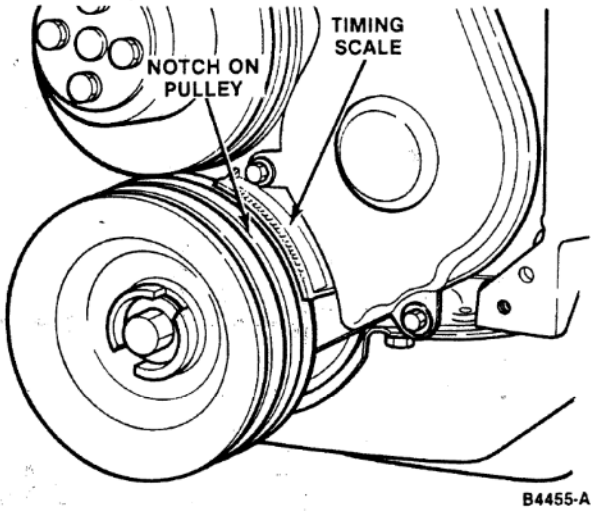
4. Separate the wiring connector spark output (SPOUT) wire.



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NOTE: Engines equipped with EEC-IV have an in-line base timing connector that must be disconnected to check base ignition timing. Disconnecting the connector interrupts the ECA's timing advance/retard signal, and guarantees that only base timing will be read during the timing check. The connector is located near the distributor, within six inches of the TFI module.

5. Start the engine and allow it to warm up to operating temperature.
6. Check engine idle speed. If idle speed is not 825-975 (M/T) or 925-1075 (A/T) rpm, it must be adjusted. If necessary, refer to Section 21-01.
7. Using the timing light, check the base timing. The notch on the crankshaft pulley should align with the timing scale as follows:
   - — Manual transmission: 13° BTDC
   - — Automatic transmission: 10° BTDC



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If timing is not within specification, loosen the distributor hold-down bolt and turn the distributor until the timing marks align. Tighten the hold-down bolt.

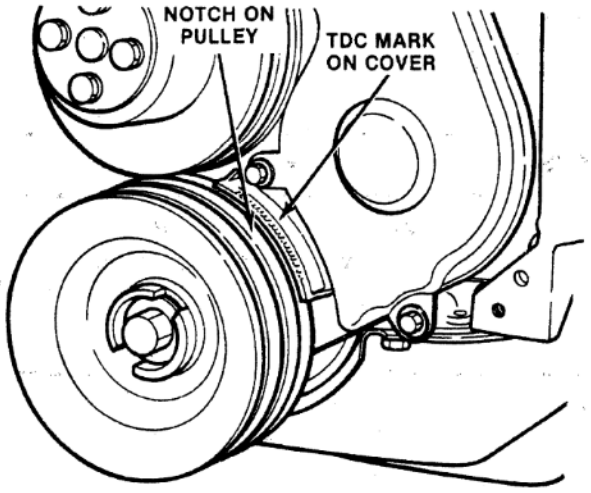
8. Shut off the engine, connect the SPOUT circuit connector, remove the timing light and remove the tachometer.

DIAGNOSTIC PROCEDURES

INITIAL TIMING CHECK

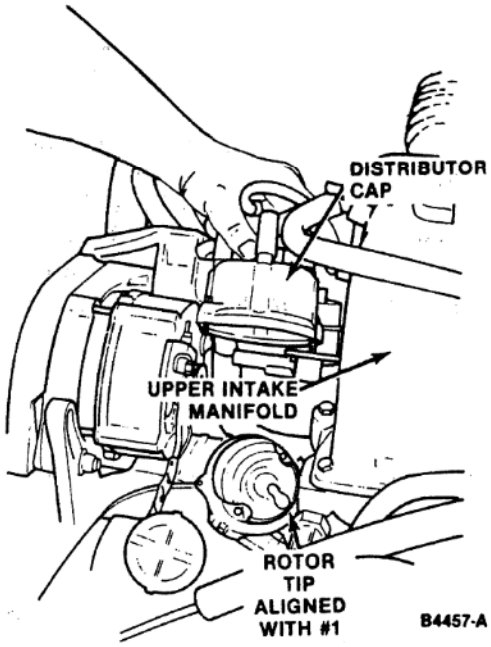
An initial timing check should be done if there is reason to believe the distributor is no longer timed to the engine. This condition can result from incorrect installation of the distributor or a timing belt that has jumped timing.

1. Remove the number one spark plug.
2. Install a compression gauge in the number one spark plug hole.
3. Connect a remote starter switch between the battery positive terminal and the starter relay "S" terminal.
4. Using the starter switch, "bump" the engine around until the gauge indicates the piston in the number one cylinder is on the compression stroke.
5. Continue "bumping" the engine until the timing mark on the crankshaft is exactly aligned with the TDC mark on the timing scale.



NOTE: If the crankshaft mark passes the TDC mark, repeat steps 4 and 5.

6. Remove the distributor cap and check that the rotor tip is pointing to the number one spark plug wire tower in the distributor cap.

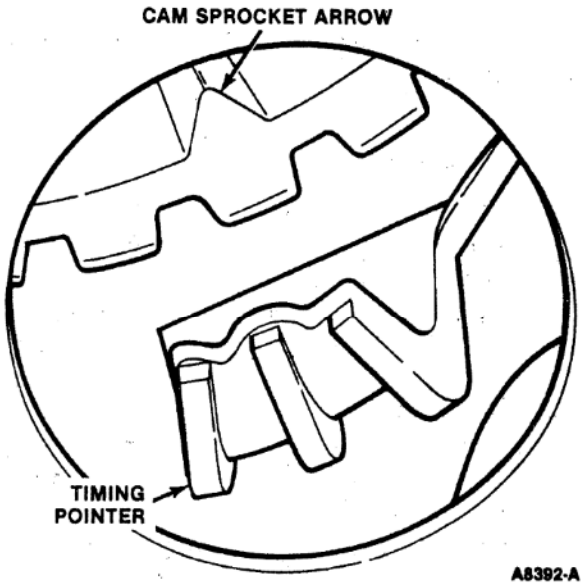


- If the rotor and distributor cap are aligned, initial timing is OK. Proceed to step 7.
- If the rotor and distributor cap do not align, remove the distributor and properly time it to the engine. Proceed to step 7.

DIAGNOSTIC PROCEDURES

INITIAL TIMING CHECK (Continued)

7. Remove the access plug from the timing belt outer cover and check that the timing mark on the cam sprocket is aligned with the timing pointer.
   - If the cam sprocket timing mark is aligned with the pointer, the engine is properly timed.
   - If the cam sprocket timing mark does not align with the pointer, the timing belt has jumped time and must be adjusted. If necessary, refer to Section 21-05.
8. Check and adjust base ignition timing. If necessary, refer to the procedure in this section.



DIAGNOSTIC CHART

SPARK PLUG TROUBLESHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
FUSED SPOT DEPOSITS (Identified by melted or spotty deposits resembling bubbles or blisters.)	Sudden acceleration	Plugs can be cleaned if not excessive. Otherwise, replace plugs.
OVERHEATING (Identified by a white or light gray insulator with small black or gray brown spots and with bluish burnt appearance of electrodes.)	• Engine overheating	• Replace plugs. Refer to Section 27-01 for diagnostic procedures.
	• Wrong type of heat range plugs	• Replace with specified plugs.
	• Loose plugs	• Replace plugs and tighten to specified torque.
	• Incorrect ignition timing	• Replace plugs. Check base timing. If necessary, refer to the procedure in this section.

DIAGNOSTIC CHARTS (Continued)

SPARK PLUG TROUBLESHOOTING CHART (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
OVERHEATING (Cont'd)	• Incorrect fuel mixture	• Replace plugs. Refer to Group 24.
CARBON FOULED (Identified by black, dry, fluffy carbon deposits on insulator tip, exposed shell surfaces and electrodes.)	• Wrong heat range plugs (too cold)	• Replace with specified plugs.
	• Weak ignition	• Make scope check of ignition system. If necessary, refer to the procedure in this section.
	• Dirty air cleaner element	• Replace element. If necessary, refer to Section 24-41.
	• Fuel mixture too rich	• Refer to Group 24.
	• Excessive idling	• Discuss condition and cause with owner.
PRE-IGNITION (Identified by melted electrode and possibly blistered insulator.)	• Wrong type of fuel	• Replace plugs. Discuss condition and cause with owner.
NOTE: Metallic deposits on insulator indicate engine damage. Refer to Section 21-01 for engine diagnosis.	• Incorrect ignition timing	• Check base timing. If necessary, refer to the procedure in this section.
	• Wrong heat range plugs	• Replace with specified plug.
	• Engine overheating	• Refer to Section 27-01 for diagnostic procedures.
	• Burned valves or other engine damage	• Refer to Section 21-01 for diagnostic procedures.
GAP BRIDGED (Identified by deposit build-up closing gap between electrodes.)	• Oil or carbon fouling	• Replace plugs. Refer to Section 21-01 for possible engine-related causes.
OIL FOULED (Identified by wet, black deposits on insulator shellbore and electrode.)	• Excessive oil entering combustion chamber through worn rings or pistons, worn valve guides	• Refer to Section 21-01 for diagnostic procedures.

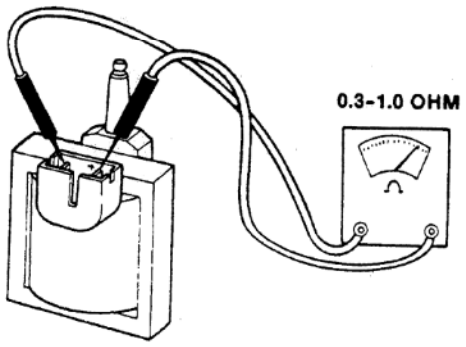
B5053-A

DIAGNOSTIC PROCEDURES

Ignition Coil Tests

The ignition coil can be tested on any conventional coil tester or with an ohmmeter. A coil tester is preferable because it can detect faults that cannot be found with an ohmmeter. The ohmmeter checks will given an indication of coil condition.

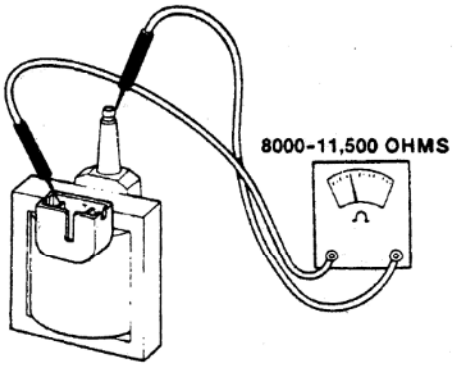
Primary Winding Resistance Test



B4460-A

1. Disconnect the wiring connector from the coil.
2. Set the ohmmeter to the x1 scale.
3. Connect the ohmmeter across the coil negative and positive terminals. The ohmmeter reading should be 0.3 to 1.0 ohm. If the reading is above or below this spec, replace the coil.

Secondary Winding Resistance Test



B4461-A

1. Disconnect the wiring connector from the coil.
2. Disconnect the coil secondary wire.
3. Set the ohmmeter to the x 1000 scale.
4. Connect the ohmmeter across the coil negative terminal and the secondary high-voltage terminal. The ohmmeter reading should be 8,000 to 11,500 ohms. If the reading is above or below this spec, replace the coil.

DIAGNOSTIC PROCEDURES

OSCILLOSCOPE CHECKS

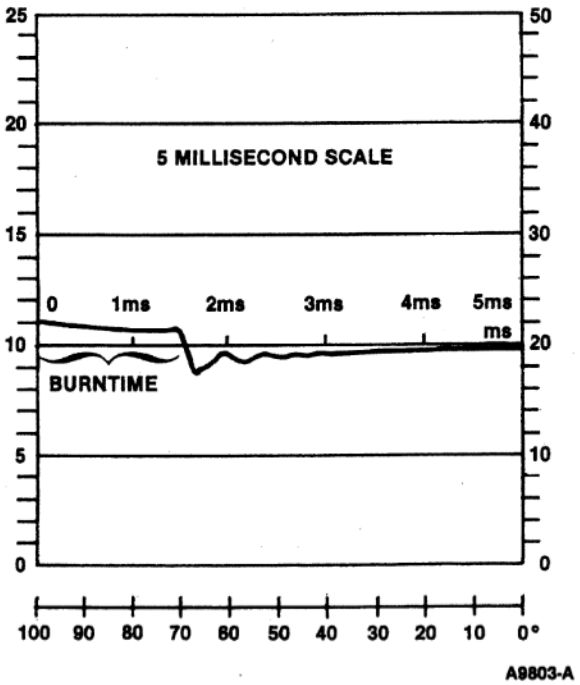
The oscilloscope provides a convenient means of observing secondary ignition circuit operation while the engine is running. It displays a graphic waveform trace pattern that reflects the actual voltages required to fire each spark plug. Through interpretation, the scope pattern can be used to diagnose conditions affecting all cylinders or just one cylinder. When connecting an engine analyzer equipped with a scope, always follow the manufacturer's instructions for hook-up and operation.

NOTE: It is essential that the calibration of the engine analyzer be maintained for accurate results.

Ignition Coil Output Test

1. Connect an engine analyzer equipped with an oscilloscope. Follow the manufacturer's instructions for hook-up and operation.
2. Start the engine.
3. Select a Secondary, superimposed pattern, with a 5ms (millisecond) sweep.
4. Observe the burn line on the screen. The burn time must be a minimum of 1ms (millisecond), and a maximum of 2ms (millisecond) in length.
   This indicates that there are sufficient coil reserves to fire the plugs, under any conditions.

CAUTION: Do NOT operate the engine with a plug wire disconnected, as this will result in damage to ignition system components.

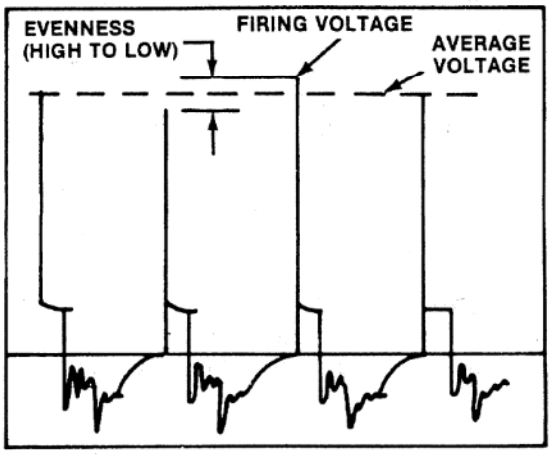


SUPPLEMENT 1

DIAGNOSTIC PROCEDURES

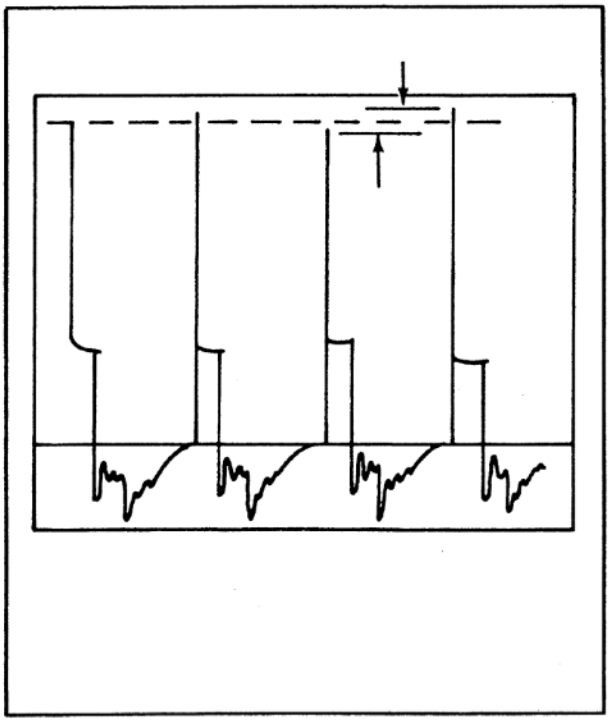
OSCILLOSCOPE CHECKS (Continued)

With the scope set to review parade display, slowly increase engine rpm from idle to 2,000 rpm and back to idle. Compare the scope displays with the illustrations in the following diagnostic illustrations.



Evenness of spark plug firing voltage: 5 kv or less. And the average value of spark plug firing voltage: 15 kv or less.	• These are normal values for a properly operating ignition system.

CB4464-A

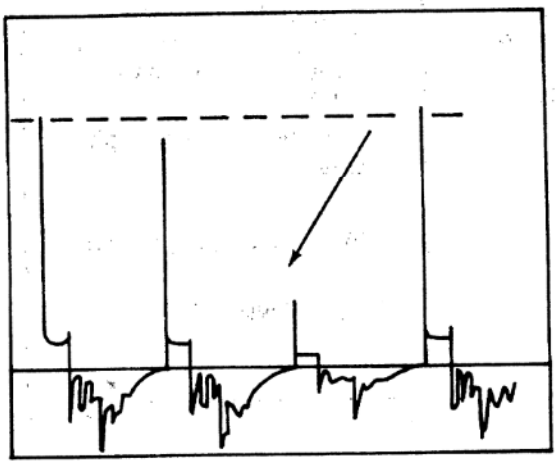


Evenness of spark plug firing voltage: 5 kv or less. And the average value of spark plug firing voltage: 15 kv or greater.	• Check ignition coil wire for proper installation in coil and distributor cap. • Measure resistance of ignition coil wire. Replace if greater than 5,000 ohms per inch. • Wide spark plug gaps—all cylinders, (usually from worn electrodes due to high mileage). • Check distributor rotor alignment.

CB4465-A

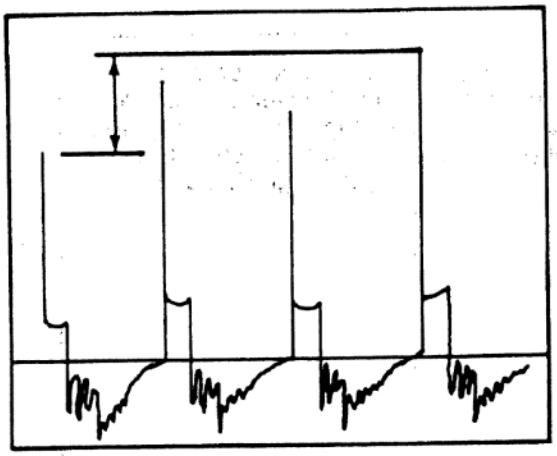
DIAGNOSTIC PROCEDURES

OSCILLOSCOPE CHECKS (Continued)



Consistently low spark plug firing voltage in one or more cylinders.	• Fouled spark plug(s). • Narrow spark plug gap(s). • Spark plug wire(s) grounding on engine. Inspect for damage. • Carbon tracking in cap.

CB4466-A

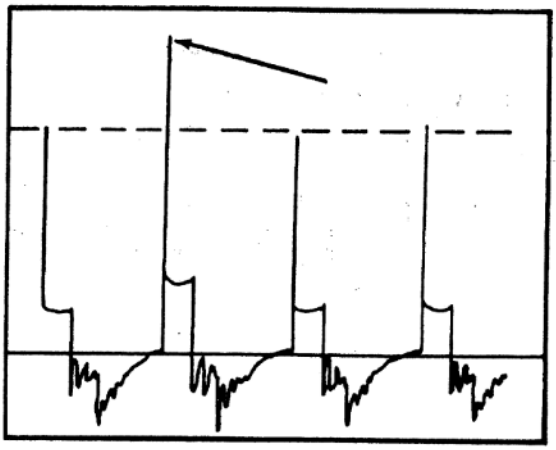


Evenness of spark plug firing voltage: 5 kv or greater.	Problems affecting some cylinders: • Wide spark plug gap(s) or worn electrode(s). • Improperly installed cap, adapter, or rotor. • Check distributor rotor alignment.

CB4467-A

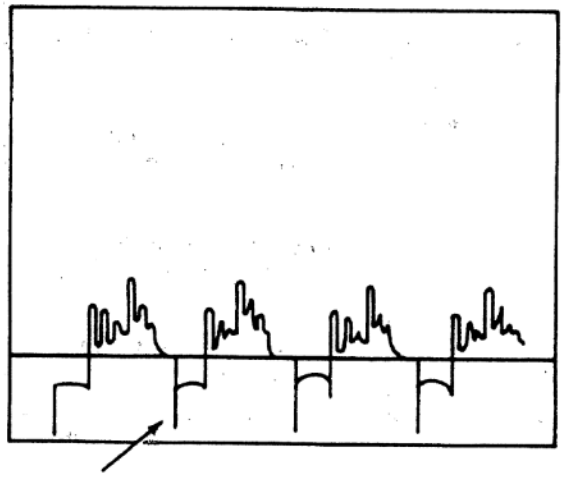
DIAGNOSTIC PROCEDURES

OSCILLOSCOPE CHECKS (Continued)



Consistently high spark plug firing voltage in one or more cylinders.	• Spark plug wire(s) not firmly connected to distributor cap or spark plug. • Disconnected spark plug wire(s). • Wide spark plug gap(s). • Open plug wire(s).

CB4468-A



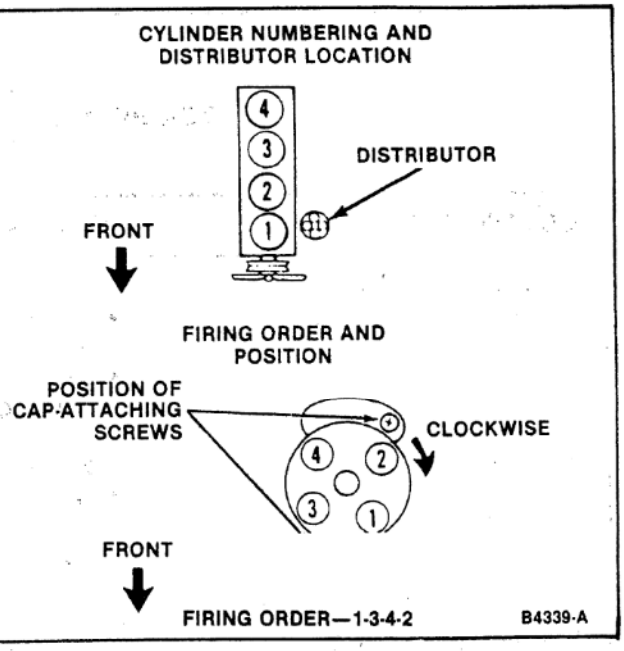
Spark plug firing voltage negative going.	Ignition coil primary circuit reversed. Check wiring harness for ignition coil primary circuit. If OK replace ignition coil.

CB4469-A

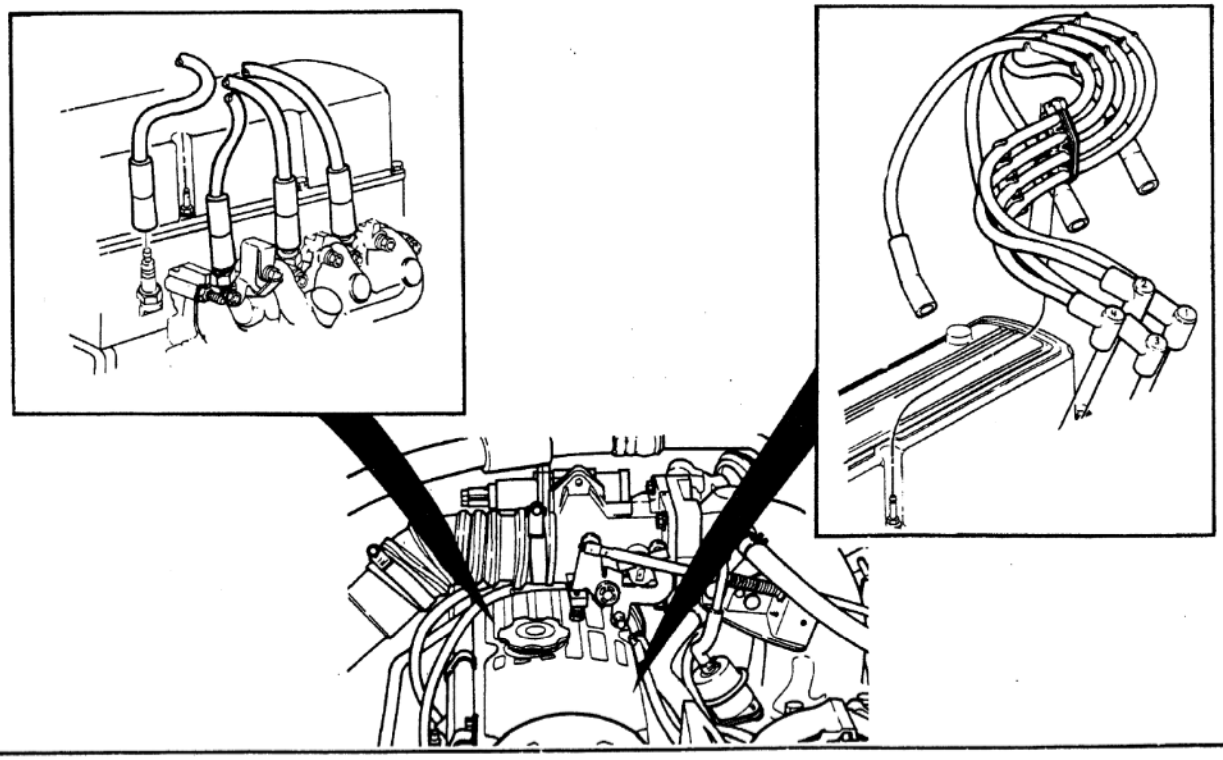
DIAGNOSTIC PROCEDURES

SPARK PLUG FIRING ORDER AND ROUTING

The secondary ignition wires must be installed in the distributor cap in a specific order and must be properly routed to the spark plugs. To match the engine firing order the spark plug wires are installed in the cap in a clockwise direction to match the clockwise rotation of the distributor rotor. Beginning with number one, the plug wires are routed, in order, to spark plugs 1-3-4 and 2.



Proper routing of the secondary wires is important to prevent induction produced misfiring. If the engine develops a missing or sputtering condition after a service procedure requiring removal or repositioning of the secondary wire, look for improper routing of these wires. The wires must be properly routed to plugs and held in position by the routing clips.



DIAGNOSTIC PROCEDURES

IGNITION SYSTEM COMPONENT INSPECTION CHART

COMPONENT	CHECK FOR
DISTRIBUTOR CAP	• Cracks • Carbon tracks • Burned or broken spark plug wire terminals • Burned or eroded terminals • Missing or broken carbon button
ROTOR	• Burned or eroded center contact • Burned or eroded tips • Cracks • Carbon tracks • Loss of center contact spring tension
SPARK PLUG WIRES	• Brittle or spongy spark plug boots • Breakdown of insulation • Excessive resistance — If ohmmeter reading exceeds 5000 ohms per inch, replace the wire.

SECTION 23-02 IGNITION SYSTEM

CONTENTS

Page

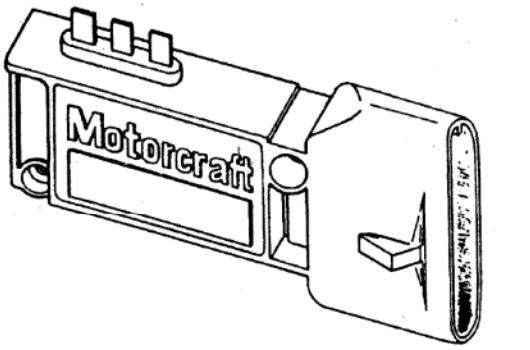
DESCRIPTION 1

REMOVAL AND INSTALLATION

- Distributor Assembly 2
- TFI-IV Ignition Module 4
- Distributor Cap and Rotor 6
- Spark Plug Wires 7
- Spark Plug 9
- Octane Rod 11

DISASSEMBLY AND ASSEMBLY

- Distributor 12



B4046-A

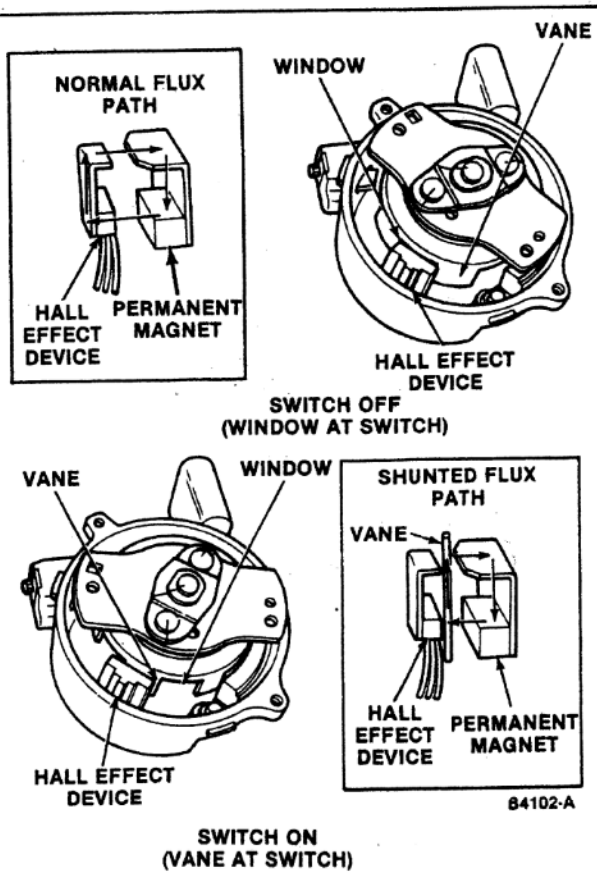
DESCRIPTION

The ignition system features a universal distributor design, driven by the auxiliary shaft. The distributor is mounted on the left side of the engine, below and behind the power steering pump. The distributor has a die-cast base which incorporates an integrally mounted TFI-IV ignition module, a Hall effect vane switch stator assembly, and an octane rod. No distributor calibration is required and initial timing is not a normal adjustment.

The universal distributor can be adjusted for octane needs by replacing the octane rod. The standard zero degree rod can be replaced with a three degree or six degree retard rod. The replacement rods are released for service only.

NOTE: Do not change timing by use of different octane rods without first having the proper authorization, as federal emission requirements will be affected.

The TFI-IV module used features a "push start" mode. This will allow "push starting" of the vehicle should it be necessary (manual transmission only).



B4102-A

DESCRIPTION

The primary function of the EEC IV System universal distributor is to direct the high secondary voltage to the spark plugs. In addition, the universal distributor supplies crankshaft position and frequency information to the ECA using a Profile Ignition Pick-Up.

The switch consists of a Hall effect device on one side and a magnet on the other. The rotary cup, which has windows and vanes, rotates and passes through the space between the Hall effect device and the magnet.

When a window is between the Hall effect device and the magnet, the magnetic flux path is not completed from the magnet through the Hall effect device and back to the magnet. In this case, the switch is off and the Hall effect device sends no signal.

When a vane passes between the device and the magnet, the magnetic lines of flux increase. The flux lines are shunted through the vane back to the magnet, increasing the effect of the magnet on the Hall effect device and the device is turned on.

When the next window passes between the device and the magnet, the device is again shut down and the signal is turned off.

The voltage pulse is used by the EEC IV system for sensing crankshaft position and computing the desired spark advance based on engine demand and calibration.

The secondary ignition wires are made from a premium wire that will withstand high temperatures. When replacing these wires, make sure the premium wires available for service are installed on the vehicle.

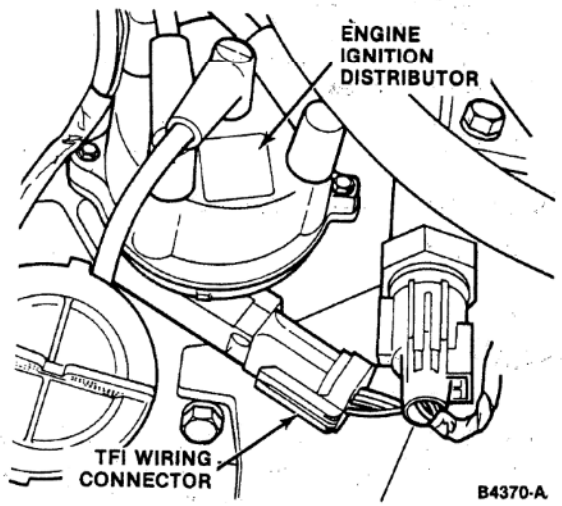
REMOVAL AND INSTALLATION

DISTRIBUTOR ASSEMBLY

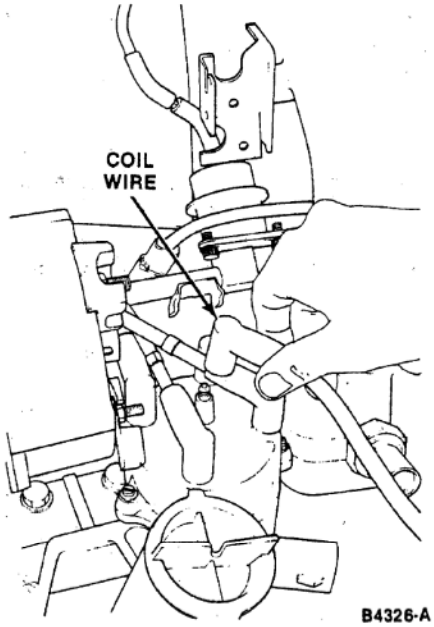
Replace the distributor assembly if service procedures other than those outlined in this section are required.

Removal

1. Disconnect the wiring connector from the TFI module.



2. Disconnect the coil wire.

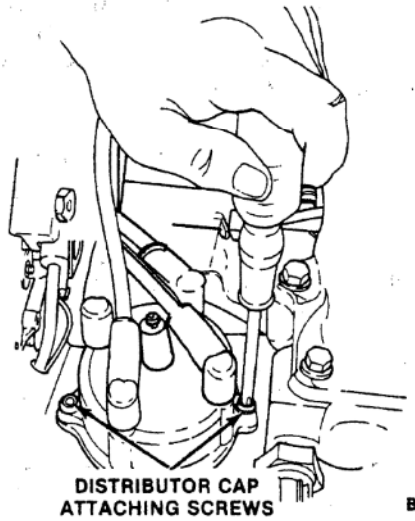


REMOVAL AND INSTALLATION

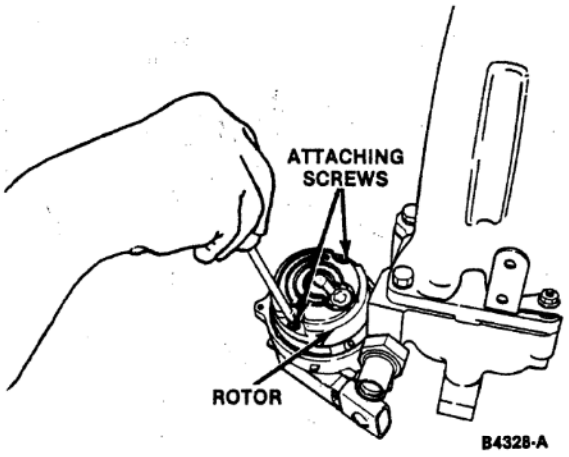
DISTRIBUTOR ASSEMBLY

Removal (Continued)

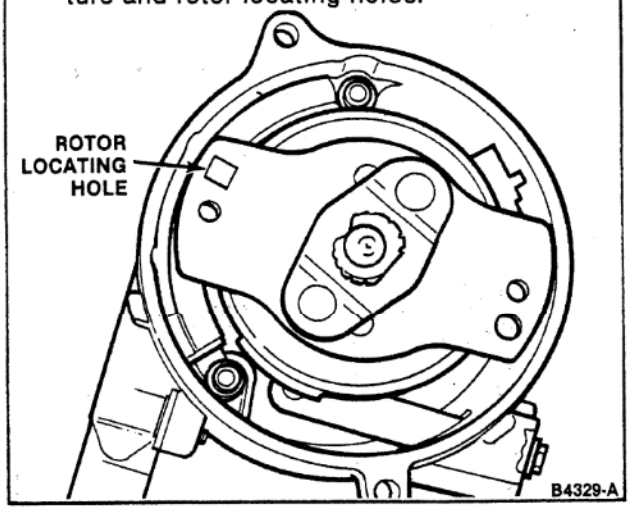
3. Using a screwdriver, remove the distributor cap and position it and the attached wires aside so as not to interfere with removing the distributor.



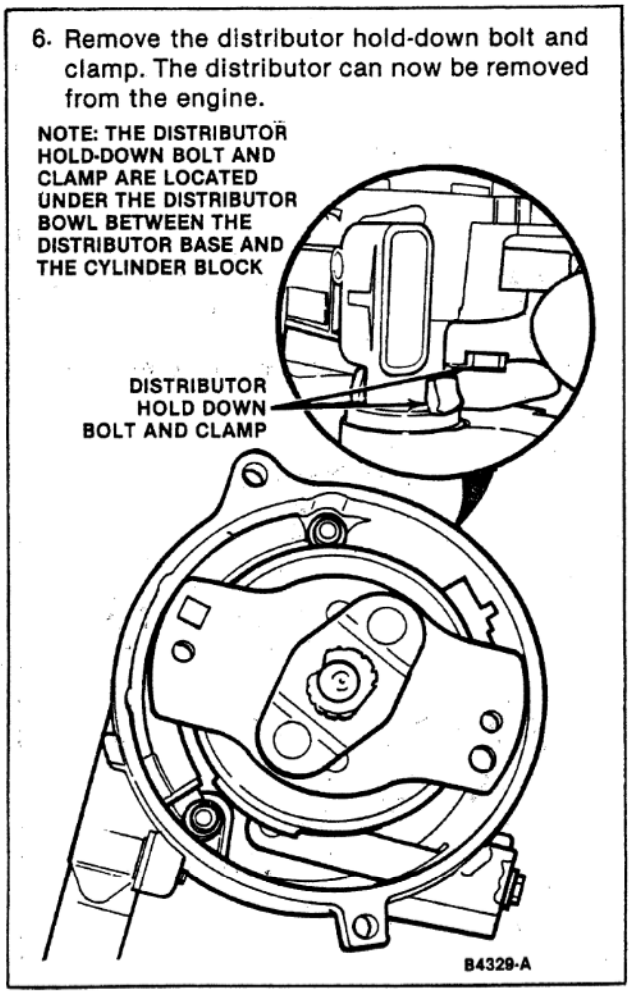
4. Loosen the distributor rotor attaching screws and remove the rotor.



5. Note the position of the shaft plate, armature and rotor locating holes.



6. Remove the distributor hold-down bolt and clamp. The distributor can now be removed from the engine.

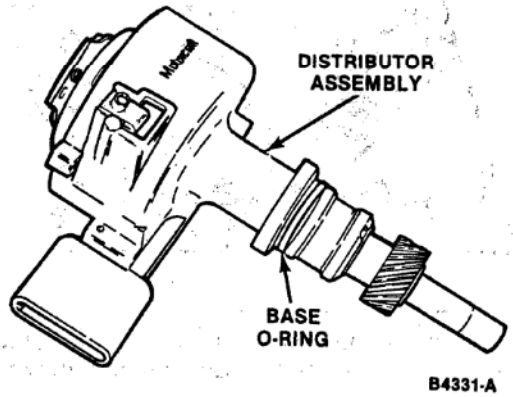


REMOVAL AND INSTALLATION

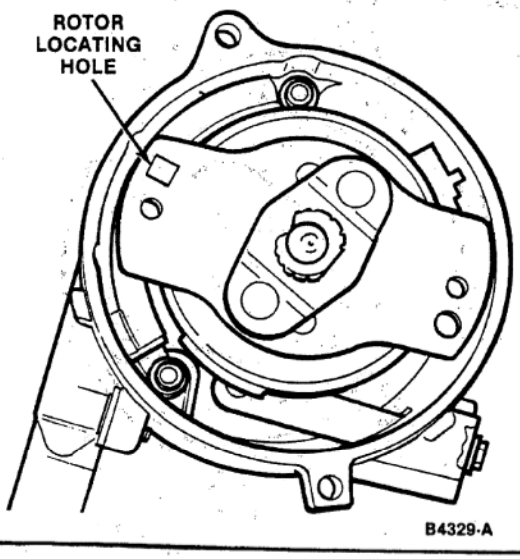
DISTRIBUTOR ASSEMBLY

Installation

1. Rotate the distributor by hand to make sure it turns freely.
2. Make sure the base O-ring is in position.



3. Position the rotor locating holes in the same location as when the distributor was removed. Install the distributor in the engine, maintaining the same orientation of the TFI-IV module to the engine as when removed.

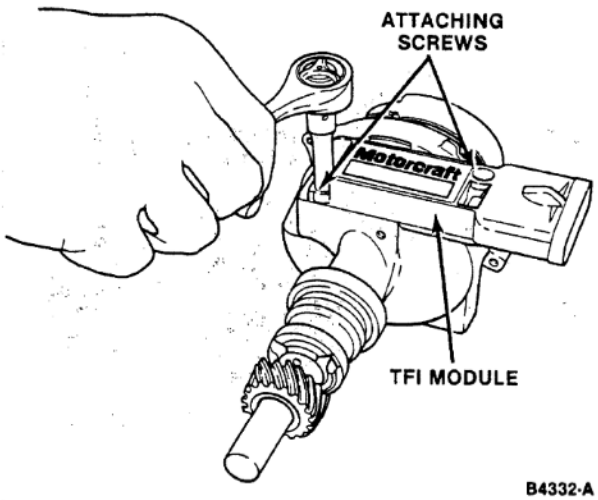


4. Install the distributor hold-down bolt and clamp and tighten so that the distributor can barely be rotated.
5. Install the distributor rotor and tighten the two screws.
6. Install the distributor cap with the attached wires. Tighten the distributor cap screws. Check all the spark plug wires to ensure they are seated in the cap.
7. Reconnect the TFI module connector to the distributor.
8. Check the ignition timing and adjust to specification. If necessary, refer to Section 23-01.
9. With the initial timing verified, tighten the distributor hold-down to 8.0 to 11.5 N·m (5.9 to 8.5 lb-ft).

TFI-IV IGNITION MODULE

Removal

1. Remove distributor from the engine. If necessary, refer to the procedure in this section.
2. Remove the TFI module attachment screws.

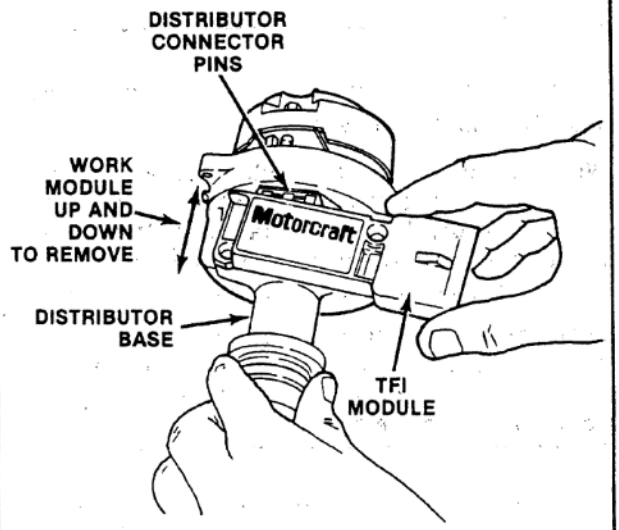


REMOVAL AND INSTALLATION

TFI-IV IGNITION MODULE

Removal (Continued)

3. Slide the right side of the module down toward the distributor mounting flange and then back up. Then, slide the left side of the module down toward the distributor mounting flange and then back up. Continue alternating, side to side, until the module terminals are disengaged from the connector in the distributor base.

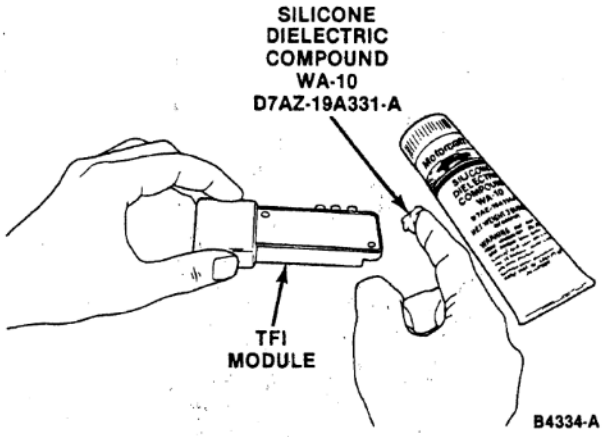


With the terminals completely disengaged, slide the module downward. Pull gently away from the mounting surface.

CAUTION: Do not attempt to lift the module from the mounting surface prior to moving the TFI module toward the distributor flange, as you will break the pins at the distributor/module connector.

Installation

1. Coat the metal base plate of the TFI ignition module uniformly with silicone compound, approximately 1/32-inch thick. Use silicone dielectric compound WA-10 D7AZ-19A331-A, or equivalent grease.



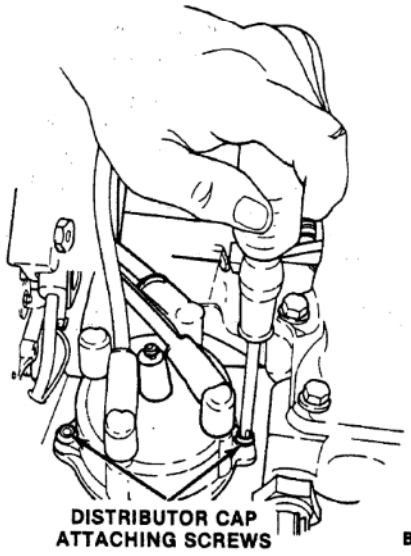
2. Place the TFI module on the distributor and carefully work into position until seated on the distributor connector pins.
3. Install and tighten the two TFI module mounting screws.
4. Install the distributor. If necessary, refer to the procedure in this section.
5. Check the ignition timing and adjust to specification. If necessary, refer to Section 23-01.
6. If the engine was originally timed with the "positive buy" timing, deface or destroy the "positive buy" timing label.

REMOVAL AND INSTALLATION

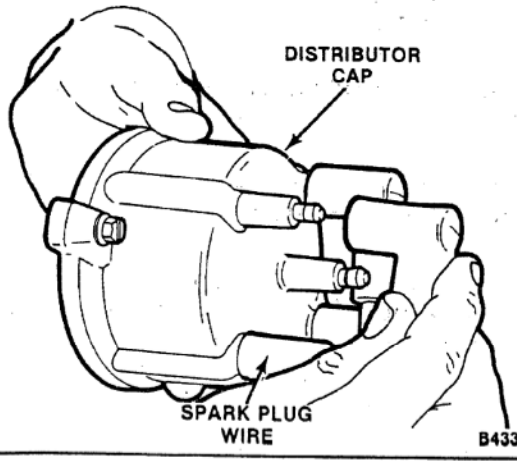
DISTRIBUTOR CAP AND ROTOR

Removal

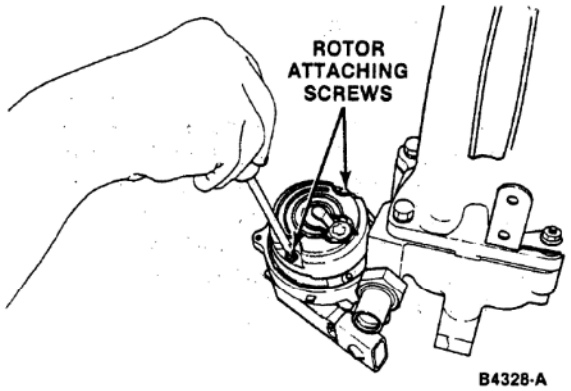
1. Remove the coil wire.
2. Loosen the distributor cap hold-down screws. Pull the cap straight off the distributor to prevent damage to the rotor points and spring.



3. Identify the location of each wire in the distributor cap and disconnect the spark plug wires from the distributor cap.



4. Loosen the rotor attaching screws and remove the rotor.



Cleaning and Inspection

Wipe the distributor cap with a clean, damp cloth. Dry the cap with compressed air. Inspect the cap for cracks, broken carbon button, carbon tracks or dirt or corrosion on the terminals. Replace the cap if it is damaged.

Wipe the rotor with a clean, damp cloth. Dry with compressed air. Inspect and replace the rotor if cracks, carbon tracks, burns, damaged points or spring are observed.

Installation

When installing a new multipoint distributor rotor, **do not** apply silicone compound to the rotor points.

1. Position the rotor on the shaft plate and install the attaching screws. Make sure the square and round locator pins are aligned with the hole in the shaft plate.
2. Position the distributor cap on the distributor base, noting the square alignment locator. Tighten the hold-down screws. Care should be taken to prevent damage to the rotor blade and spring.
3. Install the secondary wires, noting correct locations on the distributor cap. Make sure the wires are installed in the proper firing order. If necessary, refer to the spark plug wire procedures in this section.
4. Install the coil wire.

REMOVAL AND INSTALLATION

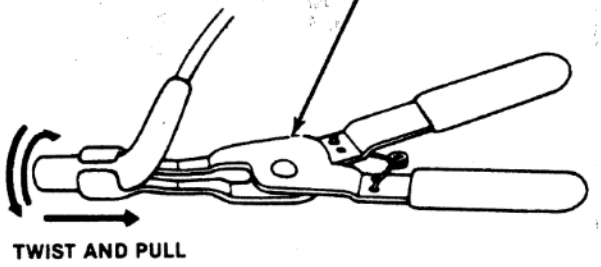
SPARK PLUG WIRES

Inspection

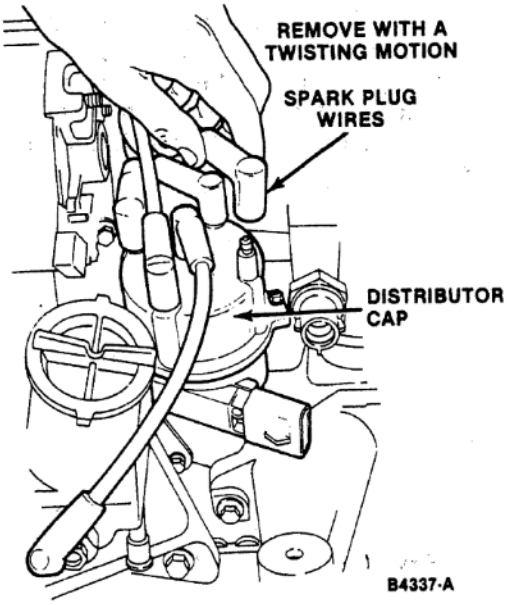
Without removing the high-tension wires from the spark plugs, distributor cap or coil, inspect them for visible damage such as cuts, pinches, cracks or torn boots. Replace only those wires that are damaged. If only the spark boot is damaged, replace just the boot.

Removal

When removing wires from spark plugs, use Tool T74P-6666-A, or equivalent. Grasp and twist the boot back and forth on the plug insulator to free the boot. Use the special tool to pull the boot from the plug. Do not pull on the wire directly, or it may become separated from the connector inside the boot.

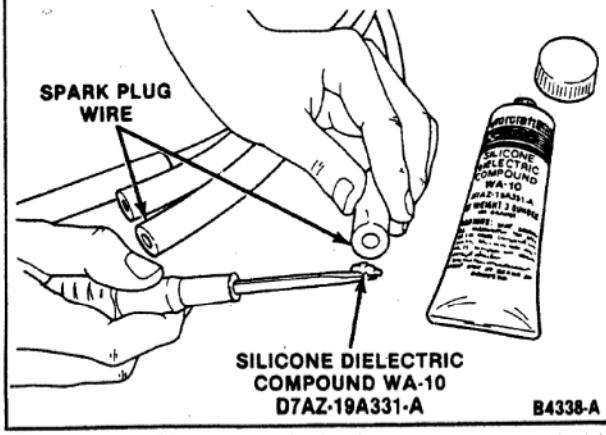


When removing wires from the distributor cap or coil, grasp the boot by hand and remove with a twisting and pulling motion. **Do not pull on the wire.**



Installation

1. Whenever a high-tension wire is removed for any reason from a spark plug, coil or distributor cap or a new high-tension wire is installed, silicone dielectric compound D7AZ-19A331-A, or equivalent, must be applied to the boot before it is reconnected. Using a small clean tool, coat the entire interior surface of the boot with Motorcraft Silicone Dielectric Compound D7AZ-19A331-A, or equivalent.

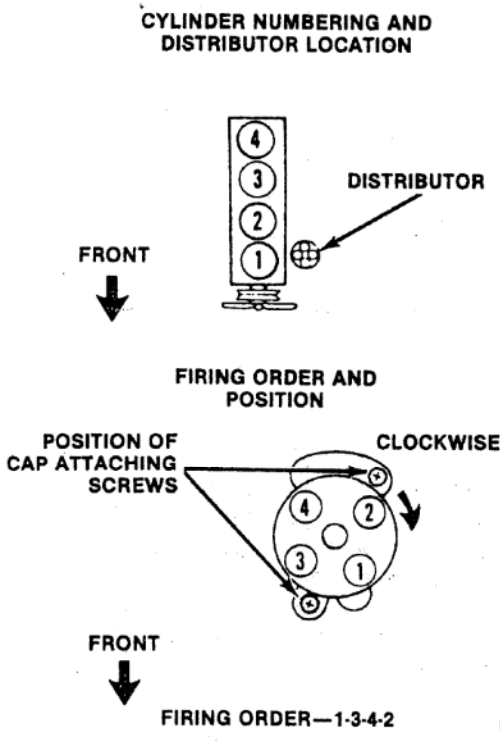


REMOVAL AND INSTALLATION

SPARK PLUG WIRES

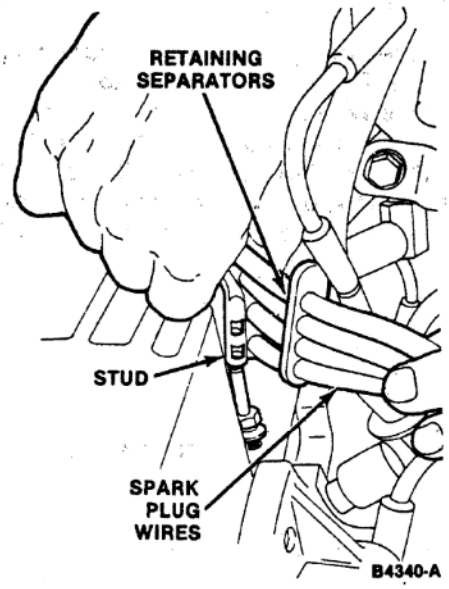
Installation (Continued)

2. Insert each wire on the proper terminal of the distributor cap. Be sure the wires are all the way down over their terminals. The No. 1 terminal is identified on the cap. Install the wires starting with No. 1. Engine firing order is shown below.



3. Remove the wire retaining separators for the old high-tension wire set and install them on the new set in the same relative position. Install the separators to the valve rocker arm covers studs.

NOTE: The secondary ignition wires are made from a premium wire that will withstand high temperatures. When replacing these wires, make sure the premium wires available for service are installed on the vehicle.



4. Connect the wires to the proper spark plugs.

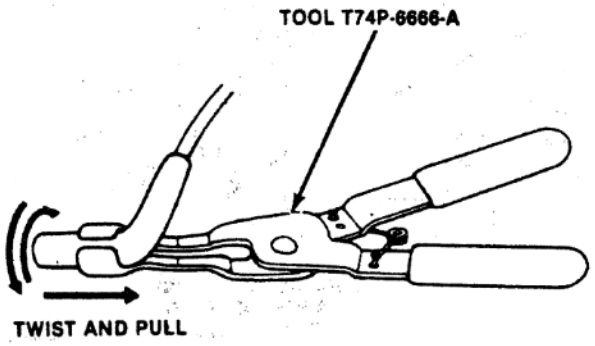
5. Install the coil wire.

REMOVAL AND INSTALLATION

SPARK PLUG

Removal

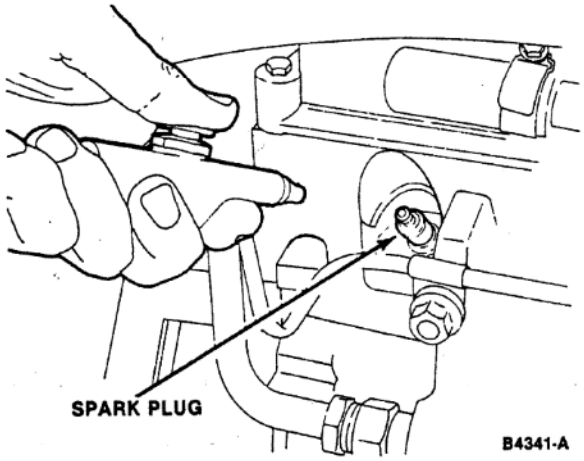
1. Remove the spark plug wire from the spark plug using Tool T74P-6666-A, or equivalent, with a twisting-pulling motion. Do not pull directly on the spark plug wire.



A6626-A

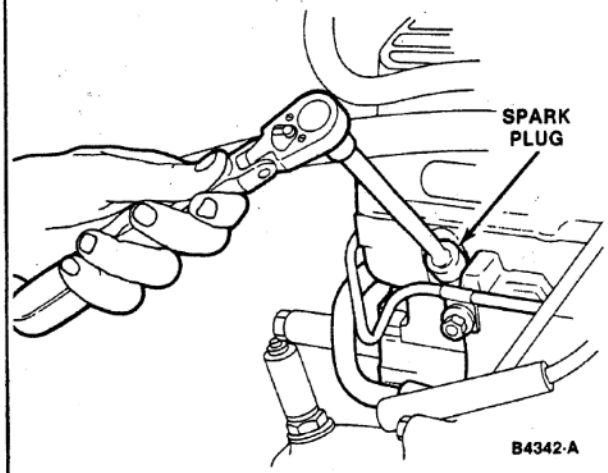
2. Inspect the spark plug wires for physical damage. Replace as necessary.

3. Clean area around each spark plug port with compressed air.



B4341-A

4. Remove the spark plug.



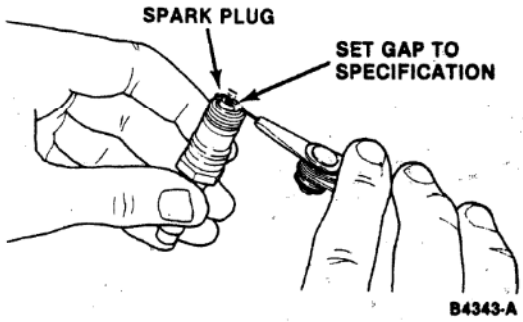
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REMOVAL AND INSTALLATION

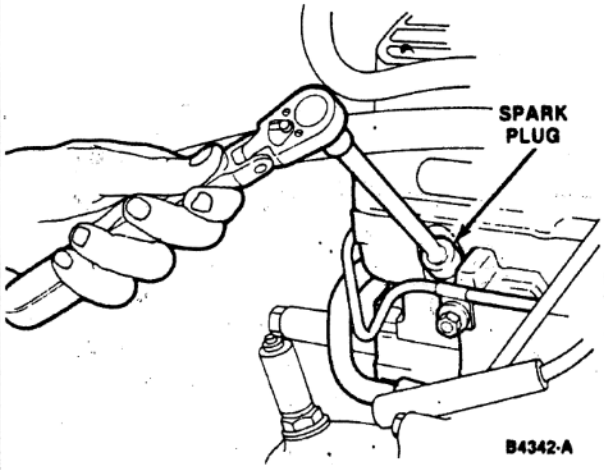
SPARK PLUG

Installation

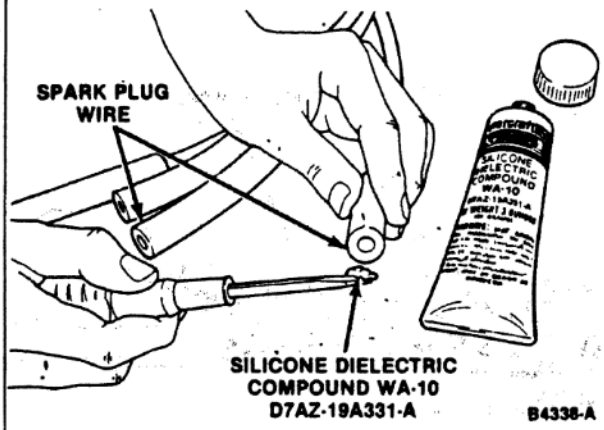
1. Set spark plug gap to specification as shown on the Vehicle Emission Control Information Decal.



2. Install the spark plug.



3. Coat the inside of the spark plug wire boot with silicone compound and install it on the spark plug.



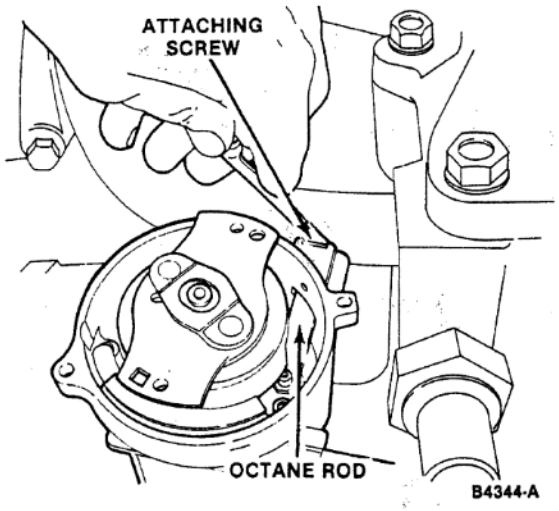
REMOVAL AND INSTALLATION

OCTANE ROD

Removal

NOTE: Do not change timing by use of different octane rods without first having the proper authorization, as federal emission requirements will be affected.

1. Remove the cap and rotor. If necessary, refer to the procedure in this section.
2. Locate the octane adjustment boss and remove the attaching screw.

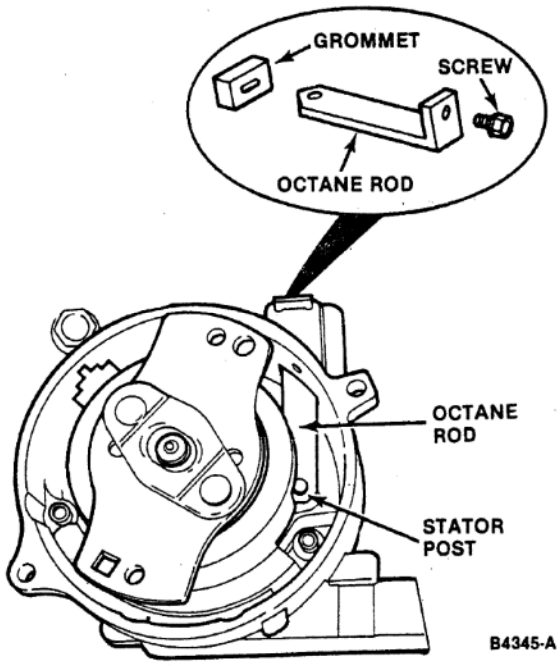


3. Slide the rod partially away from the boss on the distributor housing to a point where the stator assembly can move freely. Gently lift the rod over the stator assembly post. Remove the rod and grommet.

NOTE: Retain the grommet for use with the new rod.

Installation

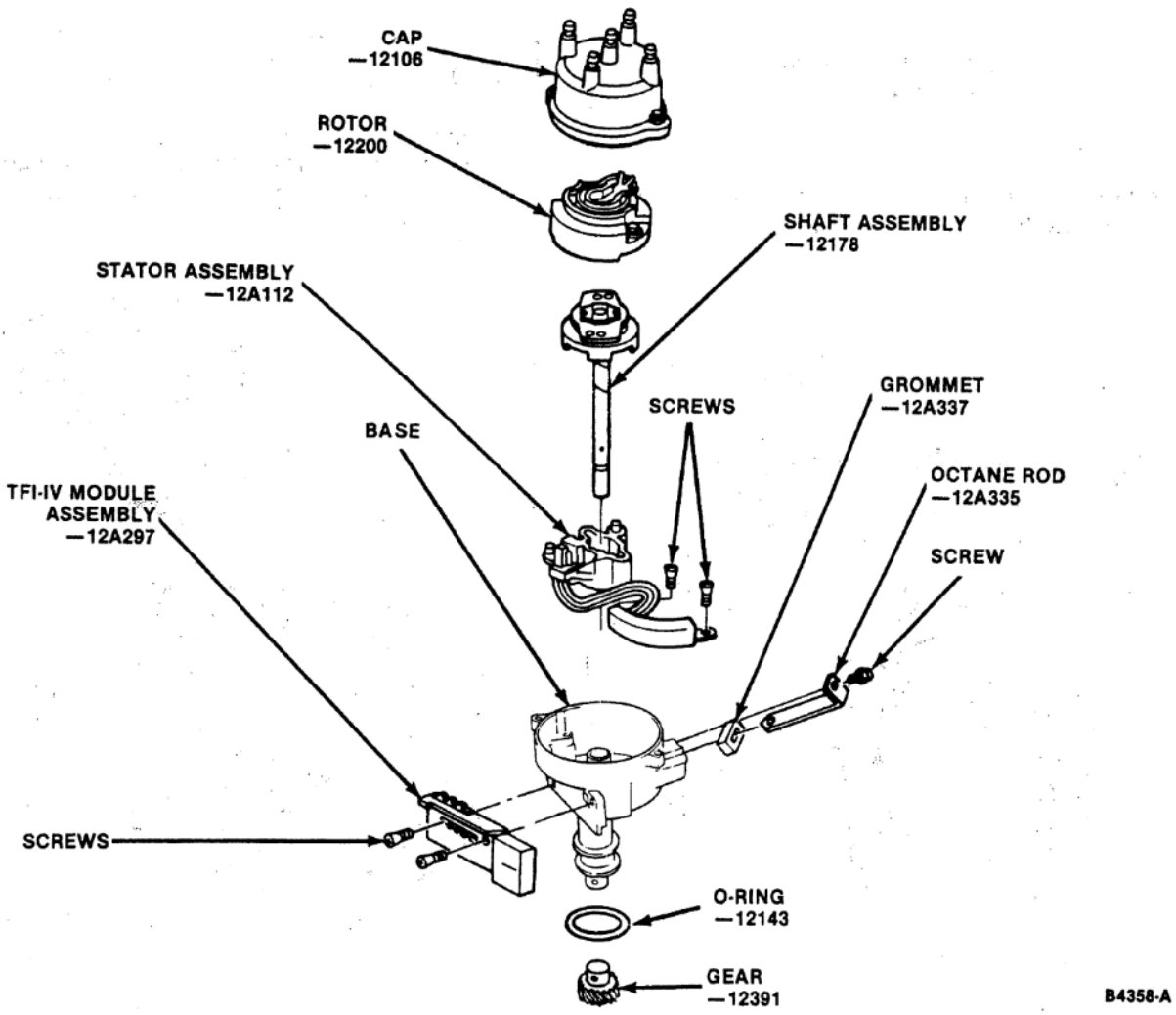
1. Install the grommet on the new service rod and reinstall in the distributor, making sure to capture the stator post with the hole in the new service rod.



2. Install and tighten the retaining screw.
3. Install the cap and rotor. If necessary, refer to the procedure in this section.

DISASSEMBLY AND ASSEMBLY

DISTRIBUTOR DISASSEMBLED VIEW

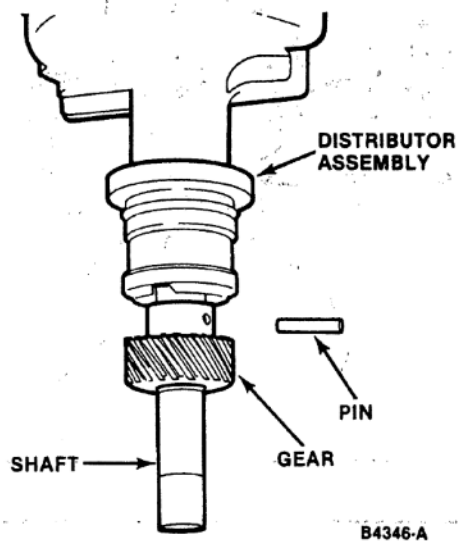


DISASSEMBLY AND ASSEMBLY

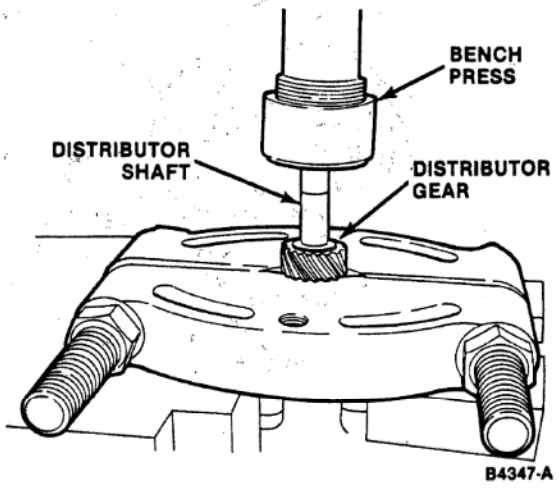
DISTRIBUTOR

Disassembly

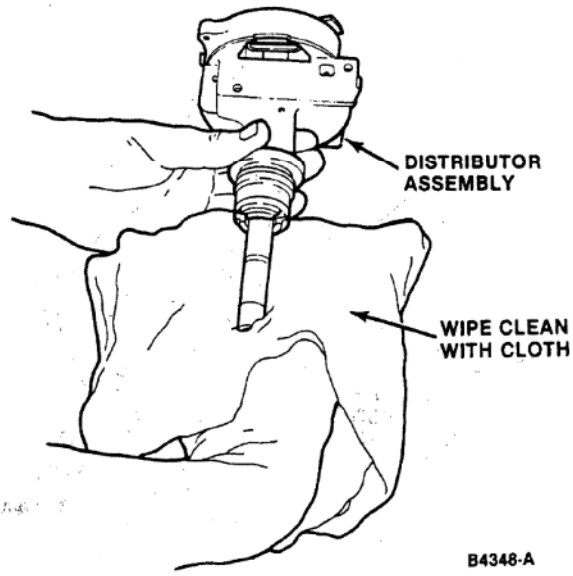
1. Remove the distributor. If necessary, refer to the procedure in this section.
2. To assist in reassembly, mark the armature and gear to note position.
3. Remove the drive gear roll pin using a suitable pin punch. Discard the pin.



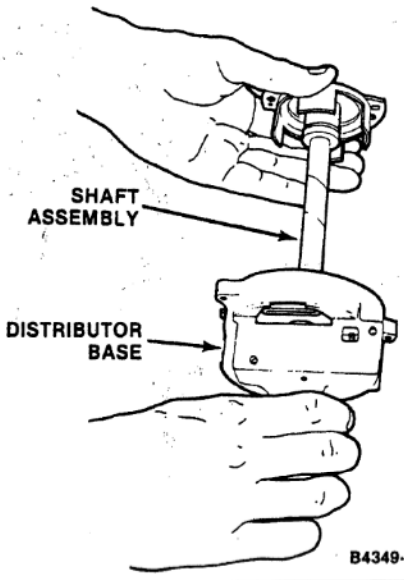
4. Using a press, remove the drive gear.



5. Deburr and polish the shaft with emery paper and wipe it clean so that it slides out freely through the shaft bushings in the distributor base.



6. Remove the shaft assembly from the base.

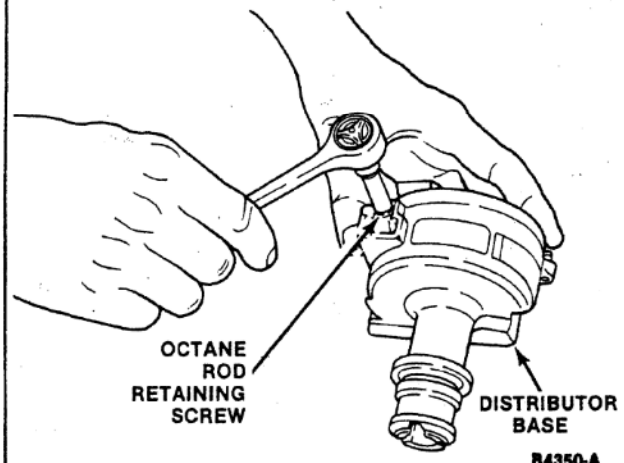


DISASSEMBLY AND ASSEMBLY

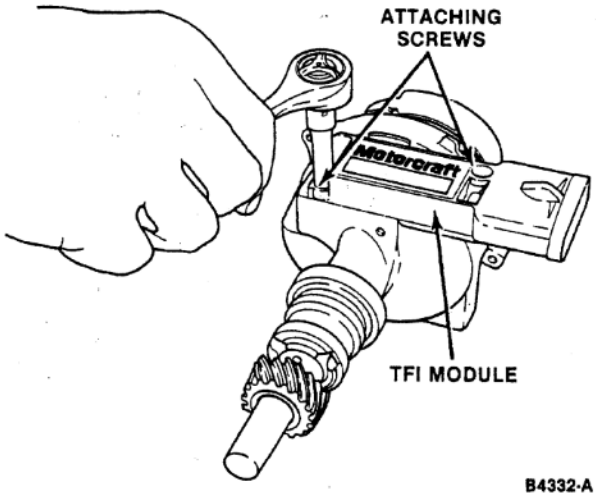
DISTRIBUTOR

Disassembly (Continued)

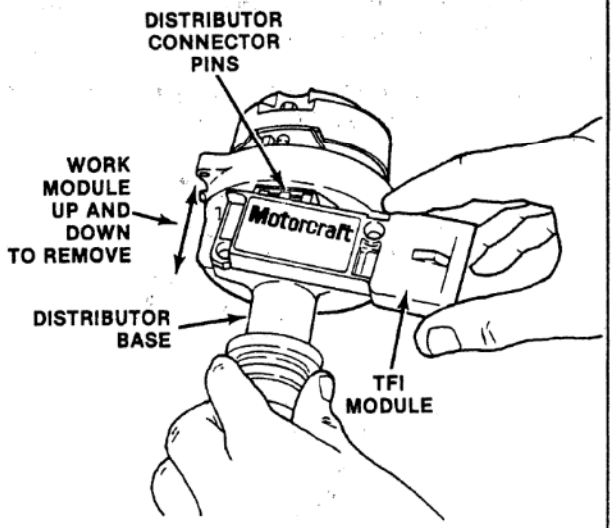
7. Remove the octane rod retaining screw.



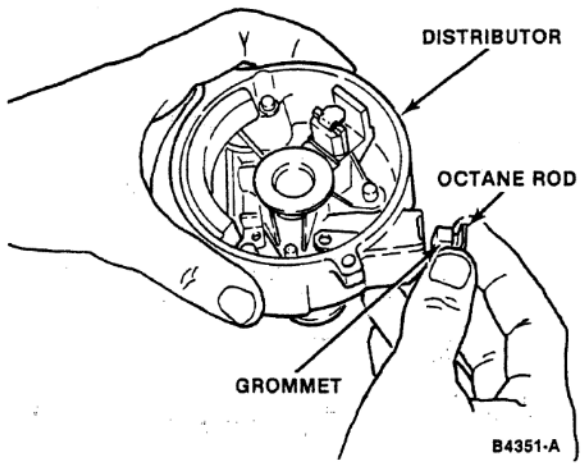
8. Remove the TFI module attaching screws.



9. Remove the TFI module. Wipe the grease from the distributor base and the module. Keep both surfaces free of dirt.



10. Remove the octane rod assembly.

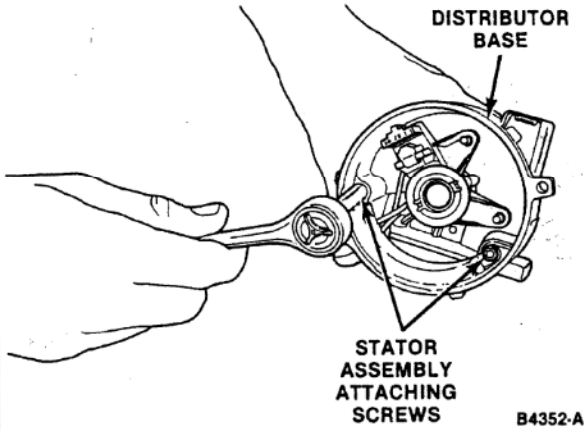


DISASSEMBLY AND ASSEMBLY

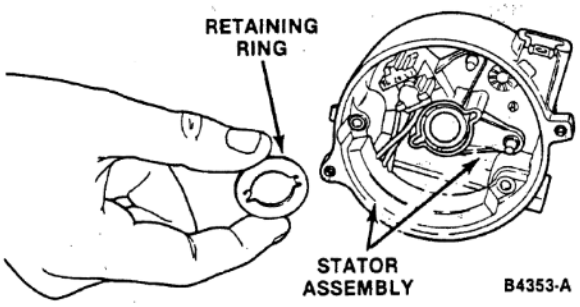
DISTRIBUTOR

Disassembly (Continued)

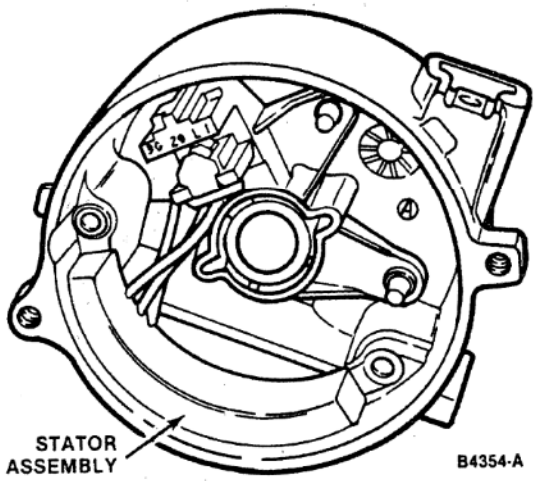
11. Remove the stator attaching screws.



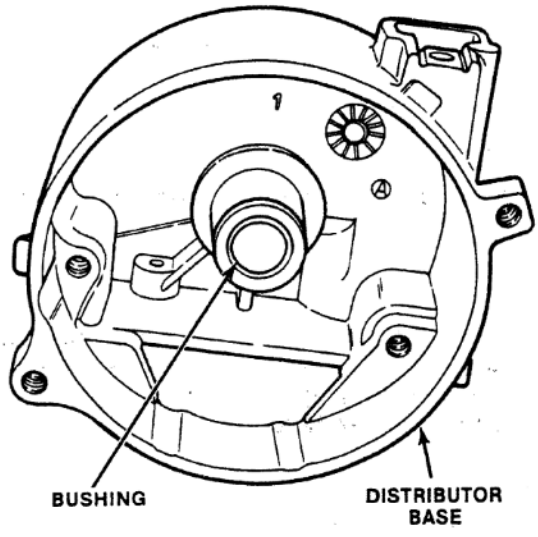
12. Remove the stator retaining ring.



13. Remove the stator assembly from the top of the distributor bowl.



14. Inspect the distributor base bushing for signs of wear or excessive heat concentration. Replace the distributor base, if damaged.

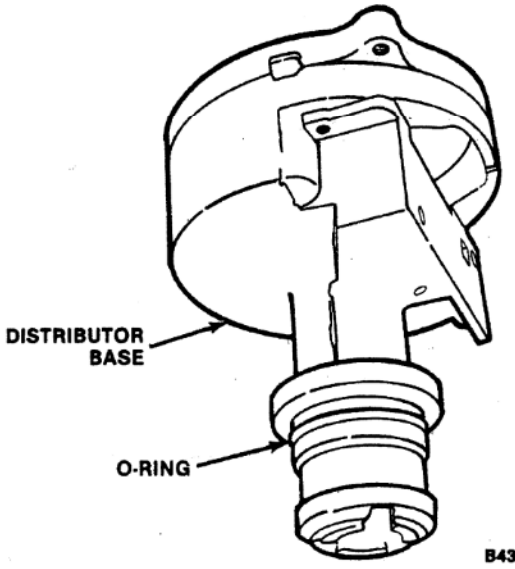


DISASSEMBLY AND ASSEMBLY

DISTRIBUTOR

Disassembly (Continued)

15. Inspect the base O-ring for cuts or damage. Replace the O-ring, if necessary.



16. Inspect the base for cracks or wear. Replace the distributor base, if it is damaged.

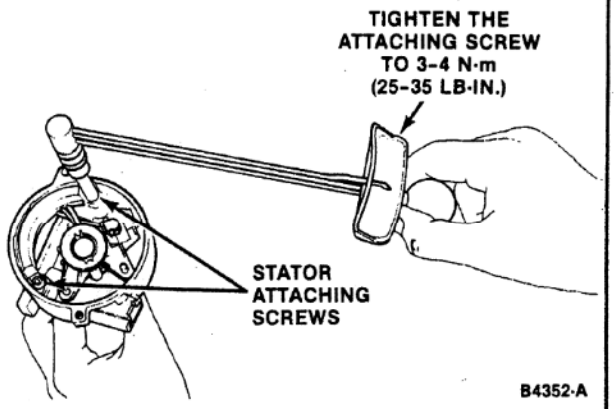
Assembly

1. Place the stator over the bushing and press down to seat.

2. Place the stator connector in position. The tab should fit in the notch on the base and the fastening eyelets should be aligned with the screw holes.

3. Install the retaining ring.

4. Install the two stator attaching screws and tighten to 3 to 4 N·m (25 to 35 lb-in.).

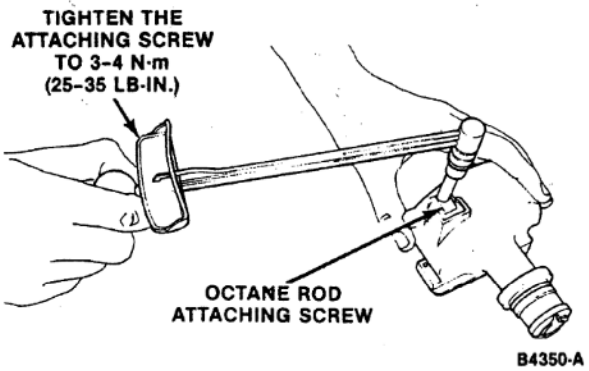


5. Install the octane rod.

6. Place the end of the octane rod onto the same post as the original stator. Only one post will easily fit in the rod hole.

7. Firmly seat the octane rod seal into the housing.

8. Install the octane rod attaching screw and tighten to 3 to 4 N·m (25 to 35 lb-in.).

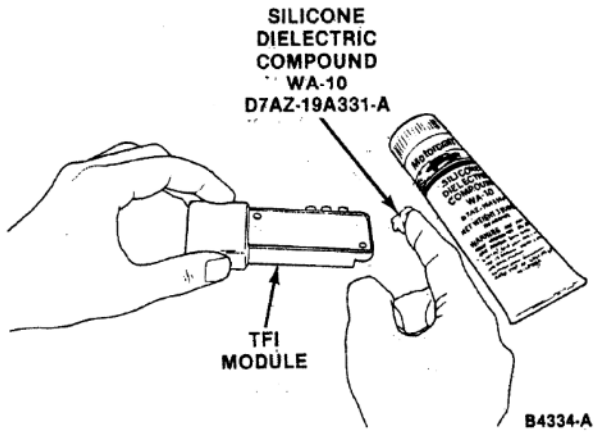


DISASSEMBLY AND ASSEMBLY

DISTRIBUTOR

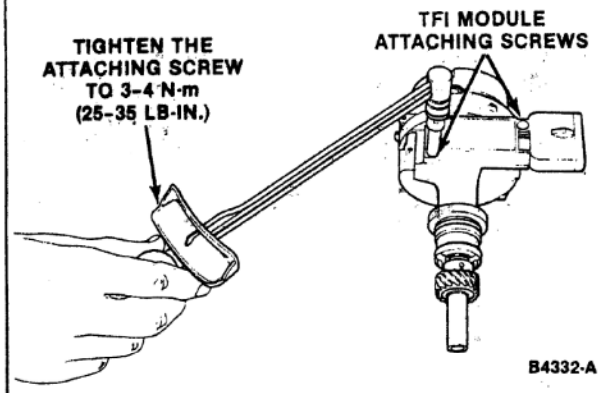
Assembly (Continued)

9. Wipe the TFI module and distributor module mounting face free of all dirt. Apply a thin, even coating of silicone dielectric compound WA-10 D7AZ-19A331-A, or equivalent grease.



10. Install the TFI module.

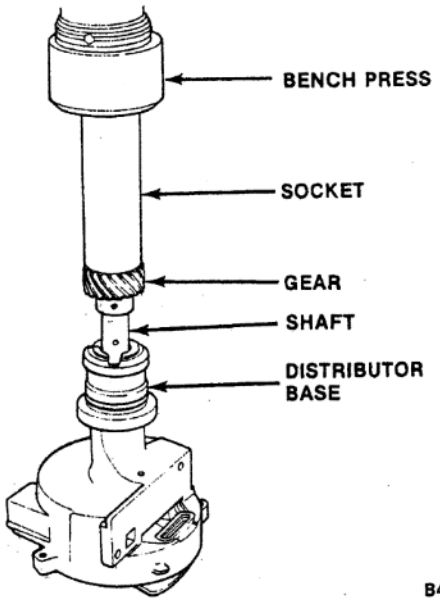
11. Install the TFI module attaching screws and tighten to 3 to 4 N·m (25 to 35 lb-in.).



12. Apply a light coat of ESF-M2C70-A, or equivalent, to the distributor shaft below the armature. Do not over lubricate.

13. Insert the shaft assembly through the base bushing.

14. Install the gear on the shaft with a bench press (and socket, if necessary), lining up the mark on the armature with the original drill hole. Use a drift punch to ensure proper alignment.



15. Install the drive gear and a new roll pin. The pin should be flush with the edge of the gear.

16. Check the distributor for free movement over the full rotation of the shaft.

17. Install the distributor. If necessary, refer to the procedure in this section.

Group 23 Specifications

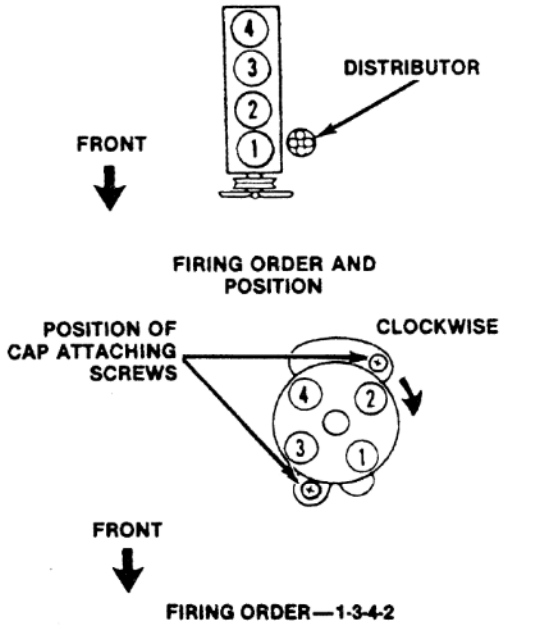
IGNITION SYSTEM DESIGN:

Thick Film Integrated (TFI) ignition module mounted on distributor. Part of Electronic Engine Control IV (EEC IV) system. No distributor calibration is required and initial timing is not a normal adjustment.

DISTRIBUTOR DRIVE: Gear driven from auxillary shaft

SERVICE SPECIFICATIONS:

Spark Plugs—AWSF32C, 14mm taperseat
Ignition Timing—13°BTDC (manual transmission)
10°BTDC (automatic transmission)
Coil Primary Winding Resistance—0.31–1.0 ohm
Coil Secondary Winding Resistance—8,000–11,500 ohms
Ignition Coil Reserve—24,000 volts
Secondary Wiring Resistance—5,000 ohms/inch maximum
Firing Order: See Illustration below



TORQUE SPECIFICATIONS

ITEM	N·m	lb-ft
Distributor hold-down to cylinder block	19-28	14-21
Spark plug to cylinder hear	9-20	7-15
Stator to distributor	3-4	25-35*
Octane rod to distributor	3-4	25-35*
Ignition module to distributor	3-4	25-35*

*inch-pounds

GROUP

FUEL SYSTEM 24

(9000)

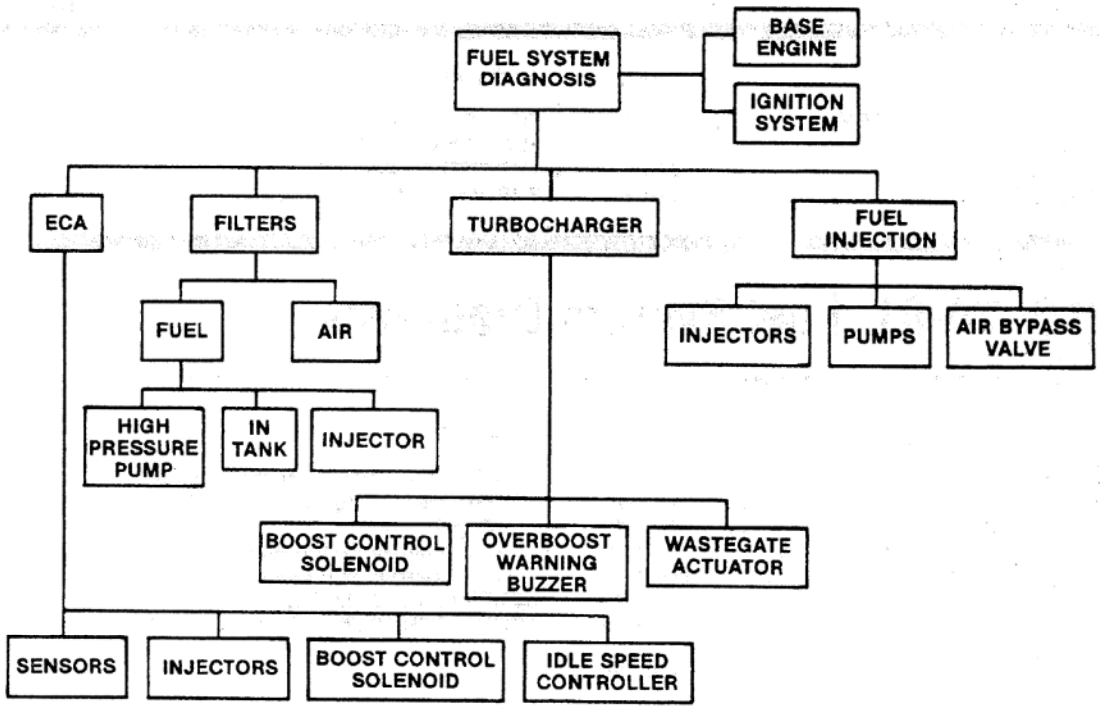
SECTION TITLE	PAGE
AIR CLEANER AND DUCT SYSTEM	24-41-1
ELECTRIC FUEL PUMPS	24-35-1
FUEL FILTERS	24-51-1
FUEL INJECTION	24-29-1
FUEL SYSTEM DIAGNOSIS	24-01-1
FUEL TANKS AND LINES	24-50-1
THROTTLE LINKAGE	24-60-1
TURBOCHARGER	24-45-1

SECTION 24-01 Fuel System Diagnosis

SUBJECT	PAGE
DIAGNOSTIC PROCEDURES	
Air Leak Check	24-01-23
Fuel Injector Functional Test	24-01-16
Fuel Injector Testing and Cleaning	24-01-16
Fuel Pump Pressure/Volume Test	24-01-14
Fuel Pump Relay Checks	24-01-13
Pressure Regulator Check	24-01-16
Turbocharger Bearing Axial Clearance Check	24-01-28
DIAGNOSTIC PROCEDURES (Cont'd.)	
Turbocharger Bearing Radial Clearance Check	24-01-29
Turbocharger Functional Check	24-01-24
Turbocharger Wastegate Actuator Check	24-01-20
GENERAL INFORMATION	24-01-2
TROUBLESHOOTING CHARTS	24-01-3

GENERAL INFORMATION

When diagnosing a condition related to the fuel system, begin with the Troubleshooting Chart to clearly define the condition. Then, use the Diagnostic Procedures to confirm the condition and to isolate the component causing the condition. To avoid unnecessary repair and replacement of parts, it is important to use a method which clearly defines and isolates the condition and its cause. In fuel system diagnosis, this task is more complicated because certain conditions may appear to be caused by the fuel system, when they are actually ignition or base engine related. That is why the cause of the condition must be clearly known before making any repairs. Diagnostic charts and procedures for the ignition system and base engine are provided in Sections 23-01 and 21-01. Fuel system diagnosis will also cross over into the area of electronic engine control. If this occurs, refer to Group H Engine/Emissions Diagnosis at the back of this Shop Manual.



V5001-B

TROUBLESHOOTING CHARTS

FUEL SYSTEM

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine cranks but will not start	Fuel tank empty	Add fuel and attempt to start engine.
	Inertia switch triggered	Locate switch in spare tire well and push button to reset.
	Fuel filter(s) plugged	Inspect and replace, if required. Refer to Section 24-51 for location and replacement procedures.
	Fuel pump(s) not operating	Check fuel pump operation and circuits. If necessary, refer to Fuel Pump Diagnostic Chart and Fuel System Pressure Test in Diagnostic Procedures part of this section.
	Fuel injector(s) not operating	Check fuel injector operation. If necessary, refer to Fuel Injector Diagnostic Chart in Diagnostic Procedures part of this section.
Lack of power	Fuel pump pressure low	Test fuel pump pressure and flow. If necessary, refer to Fuel Pump Pressure/Volume Test in Diagnostic Procedures part of this section.
	Injector(s) not operating	Check fuel injector operation. If necessary, refer to Fuel Injector Diagnostic Chart in Diagnostic Procedures part of this section.
	Turbocharger not operating	Check turbocharger operation. If necessary, refer to Turbocharger Functional Check in Diagnostic Procedures part of this section.
	Boost control solenoid not operating	Check solenoid operation. If necessary, refer to Boost Control Solenoid Diagnostic Chart in Diagnostic Procedures part of this section.

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TROUBLESHOOTING CHARTS (Continued)

FUEL SYSTEM (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Rough engine idle	Incorrect idle speed	Check idle speed and adjust as required. If necessary, refer to Section 21-01.
	Fuel injector(s) not operating	Check fuel injector operation. If necessary, refer to Fuel Injector Diagnostic Chart in Diagnostic Procedures part of this section.
	Air leaks	Isolate and correct sources of air leaks. If necessary, refer to Air Leak Check in Diagnostic Procedures part of this section.
	Injector leaking	Isolate and replace leaking injector. If necessary, refer to Fuel Injector Functional Test in Diagnostic Procedures part of this section.
High oil consumption	Turbocharger bearing seals leaking	Remove intake flexible tube and inspect for oil. If oil is present, replace turbocharger.
Spark knocking/pinging	Low-grade fuel usage	Discuss turbocharger operation and necessity for high-grade regular unleaded fuel with owner.
	Turbocharger overboost	Turbocharger wastegate actuator or boost control solenoid not operating properly. If necessary, refer to appropriate diagnostic procedure in this section.
	Knock sensor not operating	Refer to Group H located at the back of this Shop Manual.

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TROUBLESHOOTING CHARTS (Continued)

FUEL SYSTEM (Continued)

Excessive exhaust smoke	Leaking fuel injector	Isolate and replace leaking injector. If necessary, refer to Fuel Injector Functional Test in Diagnostic Procedures part of this section.
	Turbocharger leaking oil into intake	Inspect inside of compressor housing and turbine housing for signs of oil leakage.

TURBOCHARGER NOISE

The turbocharger has its own distinctive sound or noise level when operating. In many cases, malfunctions can be detected when this noise level changes. If the noise level changes to a higher pitch, it can indicate an air leak between the air cleaner and the engine, or an exhaust leak between the turbocharger and the engine. Noise level cycling from one level to another can indicate a plugged air cleaner, restriction in front of the turbocharger air inlet or heavy dirt build-up in the compressor housing and on the compressor wheel. A high-pitched whine that is most noticeable when the engine is first started but diminishes when the engine warms up indicates a problem in the turbocharger bearings. A sudden reduction in noise level with resultant black or blue smoke and excessive oil leakage indicates a complete failure. If the turbocharger bearings are suspected as the noise source, refer to the bearing radial and axial clearance checks in the Diagnostic Procedures part of this section.

CV5477-A3

DIAGNOSTIC PROCEDURES

DIAGNOSTIC CHART
FUEL PUMP

1 HIGH-PRESSURE FUEL PUMP CHECK

TEST STEP	RESULTS	ACTION TO TAKE
Turn ignition key to POSITION II (RUN) and listen for high-pressure pump to "buzz-up" to EFI system operating pressure.	High-pressure pump operates	Test results OK. Proceed to 2.
	High-pressure pump does not operate	Test results not OK. Proceed to Test 2.

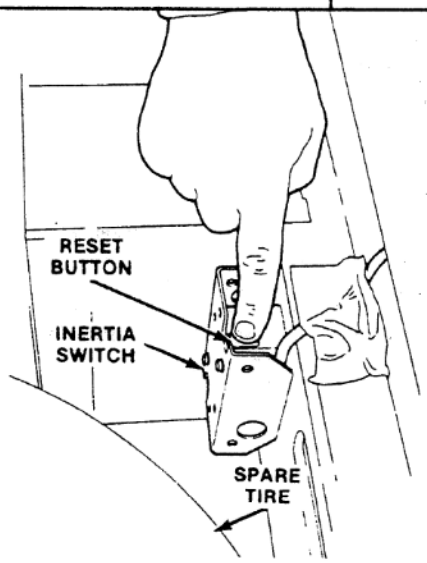
CV5003-A1

DIAGNOSTIC PROCEDURES (Continued)

DIAGNOSTIC CHART
FUEL PUMP (Continued)

2 LOW-PRESSURE FUEL PUMP CHECK

TEST STEP	RESULTS	ACTION TO TAKE
• Separate wiring connector at high-pressure fuel pump. Have helper turn ignition key to POSITION II (RUN) and listen at fuel tank for low-pressure pump "buzz."	Low-pressure pump operates (and high-pressure pump operates at Test 1)	Test results OK. Problem does not seem to be in fuel pumps. Connect pressure gauge to verify fuel delivery. If necessary, refer to Pressure Test Diagnostic Procedure in this section.
	Low-pressure pump does not operate (and high-pressure pump does not operate at Test 1)	Test results not OK. Proceed to Test 3.
	Low-pressure pump does not operate (but high-pressure pump operates at Test 1)	Test results not OK. Proceed to Test 12.
	Low-pressure pump operates (but high-pressure pump does not operate at Test 1)	Test results not OK. Proceed to Test 15.
3 INERTIA SWITCH CHECK		
Locate inertia switch in spare tire well and push down on reset button.	Switch did not require resetting	Test results OK. Proceed to 4.
	Switch resets	With switch reset, pumps should operate. Return to 1 to verify.



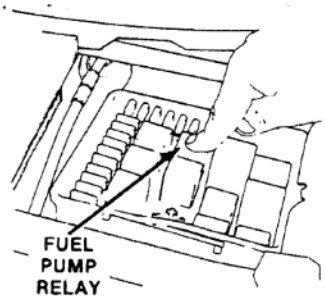
CV5003-A2

DIAGNOSTIC PROCEDURES (Continued)

DIAGNOSTIC CHART
FUEL PUMP (Continued)

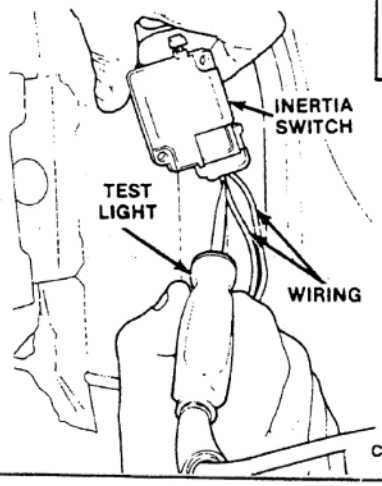
4 FUEL PUMP RELAY CHECK

TEST STEP	RESULTS	ACTION TO TAKE
• Open hood and remove cover from circuit protection panel in cowl area near left rear corner of engine compartment. Place a finger on relay to feel relay "click" and have a helper turn the ignition key to POSITION II (RUN).	Relay clicks	Test results OK. Proceed to Test 5.
	Relay does not click	Remove relay and test. If necessary, refer to the Relay Check Diagnostic Procedures. • If relay tests OK, install in panel and proceed to Test 5. • If relay tests bad, replace. With this repair, pumps should operate. Return to Test 1 to verify.



5 INERTIA SWITCH WIRING CHECK

• Turn ignition switch to POSITION II (RUN) and using a test light, check for battery voltage at both inertia switch wires.	Light on at both wires	Test results OK. Proceed to Test 6.
	Light does not come on at either wire	Check for open in circuit 361.
	Light on at one wire	Replace inertia switch. With this repair, pumps should operate. Return to Test 1 to verify.

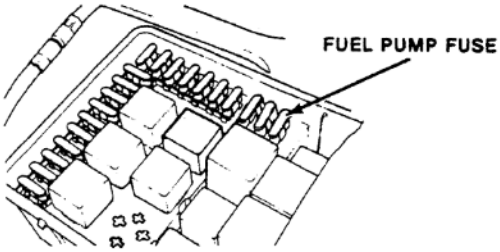


DIAGNOSTIC PROCEDURES (Continued)

DIAGNOSTIC CHART
FUEL PUMP (Continued)

6 IN-LINE FUSE CHECK

TEST STEP	RESULTS	ACTION TO TAKE
• Check fuel pump fuse (position 20 in circuit protection panel).	Fuse not blown	Test results OK. Proceed to Test 7.
	Fuse blown	Replace fuse and attempt to start engine. With this repair, pumps should operate. Return to Test 1 to verify.



7 FUSE TO PUMP CIRCUIT CHECK

• Remove 15 amp fuse from circuit protection panel and connect jumper from alternator output terminal to one wire in fuse holder. If pump does not operate, move jumper to other wire in fuse holder.	Pumps operate	Test results OK. Proceed to 8.
	Pumps do not operate	Repair open in circuit. With this repair, pumps should operate. Return to Test 1 to verify.

8 RELAY TO FUSE CONTINUITY CHECK

• Remove fuel pump relay from circuit protection panel. Using an ohmmeter, check for continuity between fuse terminal and relay terminal 87 in panel.	Continuity	Test results OK. Proceed to Test 9.
	No continuity	Test results not OK. Repair open in circuit. With this repair, pumps should operate. Return to Test 1 to verify.

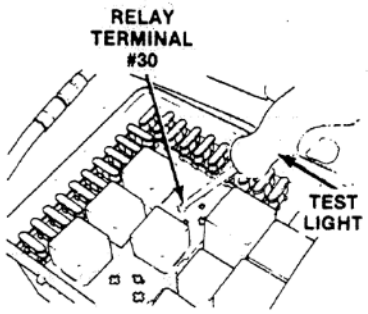
CV5003-A4

DIAGNOSTIC PROCEDURES (Continued)

DIAGNOSTIC CHART
FUEL PUMP (Continued)

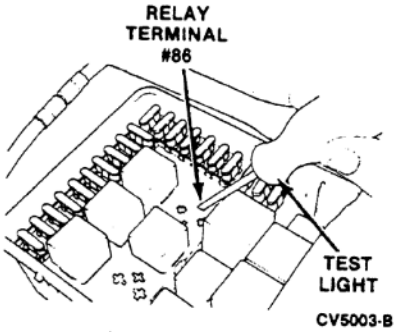
9 POWER FEED TO RELAY POINTS CHECK

TEST STEP	RESULTS	ACTION TO TAKE
• Remove fuel pump relay from circuit protection panel and connect test light from ground to relay terminal 30 in panel.	Light on	Test results OK. Proceed to Test 10.
	Light off	Test results not OK. Repair open in circuit. With this repair, pumps should operate. Return to Test 1 to verify.



10 POWER FEED TO RELAY COIL CHECK

• Connect test light from ground to relay terminal 86 and turn ignition switch to POSITION II (RUN) and watch test light.	Light on	Test results OK. Proceed to Test 11.
	Light off	Test results not OK. Repair open in circuit. With this repair, pumps should operate. Return to Test 1 to verify.



CV5003-B

CV5003-A5

DIAGNOSTIC PROCEDURES (Continued)

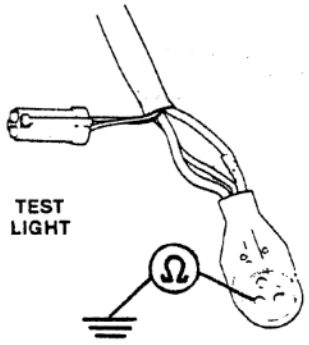
DIAGNOSTIC CHART
FUEL PUMP (Continued)

11 RELAY TO ECA CONTINUITY CHECK

TEST STEP	RESULTS	ACTION TO TAKE
• Using an ohmmeter, check for continuity between relay terminal 85 and ECA pin 22.	Continuity	Test results OK. Problem does not seem to be in pump circuit. Refer to 1985 Engine/Emissions Diagnosis Manual for further diagnosis.
	No continuity	Test results not OK. Repair open in circuit. With this repair, pumps should operate. Return to Test 1 to verify.

12 LOW-PRESSURE PUMP FEED CIRCUIT CHECK

• Lower fuel tank. If necessary, refer to Section 24-50. Disconnect fuel pump wiring connector and connect test light from ground to black/red wire in harness side of wiring connector. Have helper turn ignition switch to POSITION II (RUN) and watch test light.	Light on for about one second and then off	Test results OK. Proceed to Test 13.
	Light does not come on	Test results not OK. Repair open in feed circuit. With this repair, pump should operate. Return to Test 1 to verify.



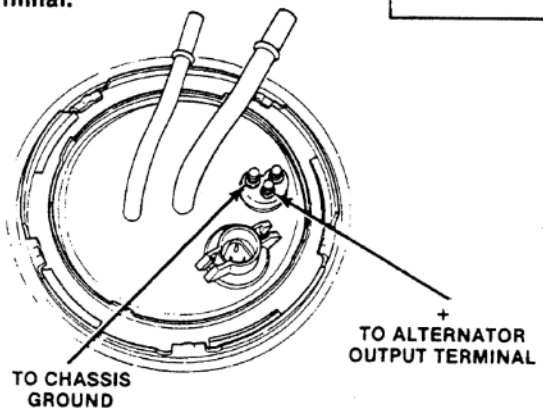
CV5003-A6

DIAGNOSTIC PROCEDURES (Continued)

DIAGNOSTIC CHART
FUEL PUMP (Continued)

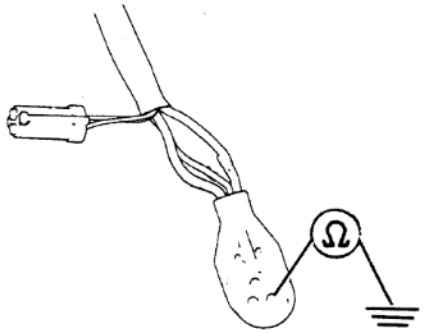
13 LOW-PRESSURE PUMP OPERATIONAL CHECK

TEST STEP	RESULTS	ACTION TO TAKE
• Connect jumper wire from pump ground terminal to a clean underbody ground and connect another jumper from pump feed terminal to alternator output terminal. **CAUTION: Make sure last connection is at alternator output terminal.**	Pump operates	Test results OK. Proceed to 14.
	Pump does not operate	Test results not OK. Replace low-pressure pump. With this repair, pump should operate. Return to Test 1 to verify.



14 LOW-PRESSURE PUMP GROUND CIRCUIT CHECK

• Using an ohmmeter, check for continuity between a clean underbody ground and ground wire in pump wiring harness.	No continuity	Test results not OK. Repair open in pump ground wire. With this repair, pump should operate. Return to Test 1 to verify.



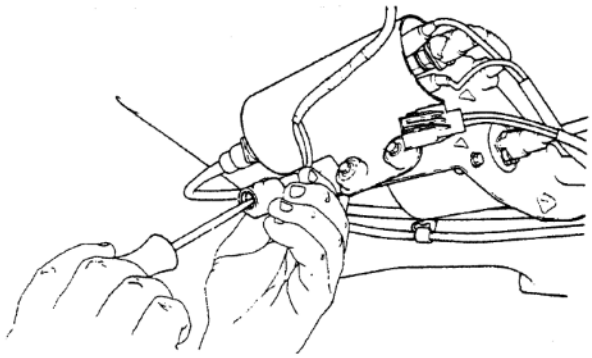
CV5003-A7

DIAGNOSTIC PROCEDURES (Continued)

DIAGNOSTIC CHART
FUEL PUMP (Continued)

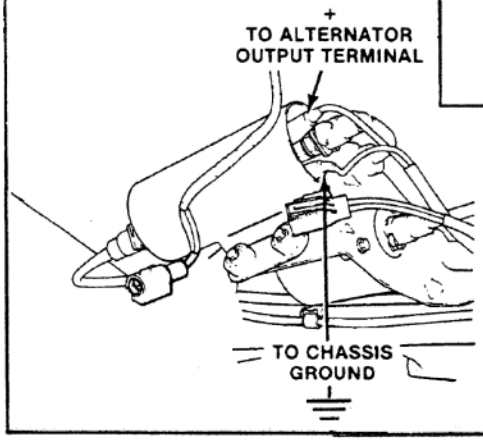
15 HIGH-PRESSURE PUMP FEED CIRCUIT CHECK

TEST STEP	RESULTS	ACTION TO TAKE
• Separate high-pressure pump wiring connector and connect test light from ground to black/red wire in harness side of wiring connector. Have helper turn ignition switch to POSITION II (RUN) and watch test light.	Light on for about one second and then off	Test results OK. Proceed to 16.
	Light does not come on	Test results not OK. Repair open in feed circuit. With this repair, pump should operate. Return to Test 1 to verify.



16 HIGH-PRESSURE PUMP OPERATIONAL CHECK

• Connect jumper wire from pump ground terminal to a clean underbody ground and connect another jumper from pump feed terminal to alternator output terminal.	Pump operates	Test results OK. Proceed to 17.
	Pump does not operate	Test results not OK. Replace high-pressure pump. If necessary, refer to Section 24-35. With this repair, pump should operate. Return to Test 1 to verify.



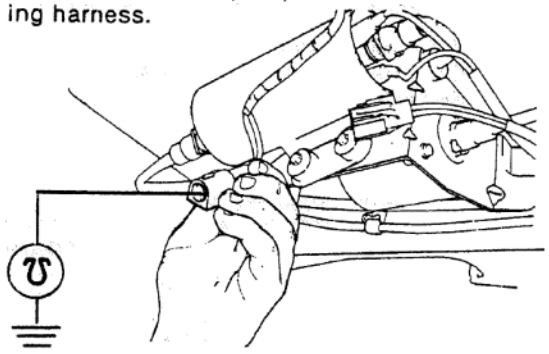
CV5003-A8

DIAGNOSTIC PROCEDURES (Continued)

DIAGNOSTIC CHART
FUEL PUMP (Continued)

17 HIGH-PRESSURE PUMP GROUND CIRCUIT CHECK

TEST STEP	RESULTS	ACTION TO TAKE
• Using an ohmmeter, check for continuity between a clean underbody ground and the ground wire in the pump wiring harness.	No continuity	Test results not OK. Repair open in pump ground wire. With this repair, pump should operate. Return to Test 1 to verify.

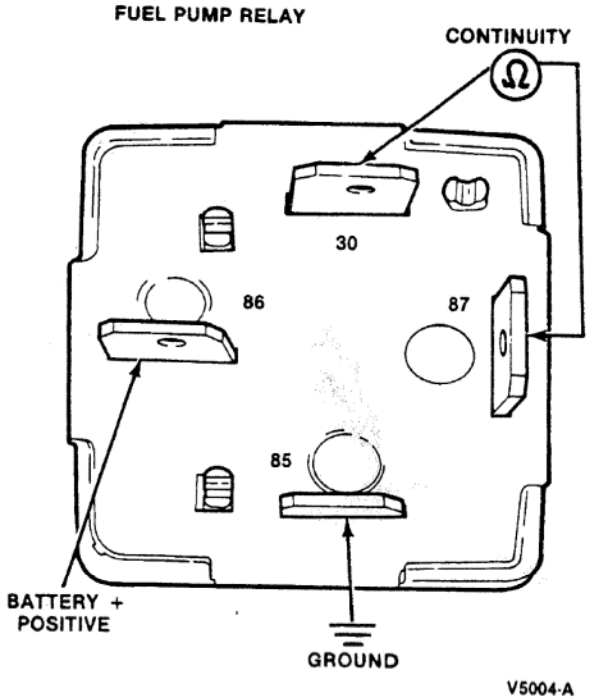


CV5003-A9

Fuel Pump Relay Checks

NOTE: The fuel pump relay is located in the circuit protection panel which is in the cowl near the left rear corner of the engine compartment.

1. Remove the fuel pump relay from the circuit protection panel.
2. Connect an ohmmeter between terminals 85 and 86 on the face of the relay. If the meter reads more or less than 85 ohms, replace the relay.
3. Connect a jumper wire from the alternator output terminal to relay terminal 86 and another jumper wire from relay terminal 85 to a clean chassis ground. When the ground connection is made, the relay should click and an ohmmeter should show continuity between relay terminals 85 and 30. If the relay does not show continuity, it must be replaced.

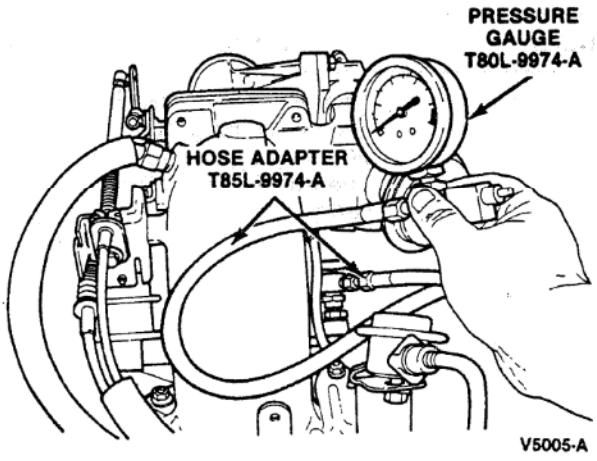


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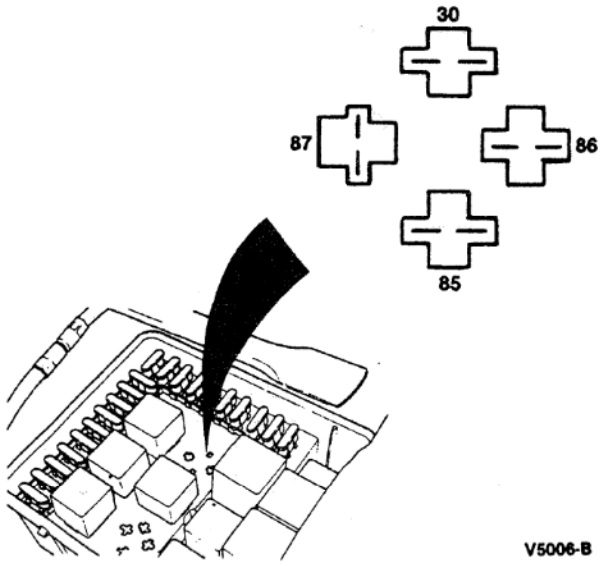
DIAGNOSTIC PROCEDURES (Continued)

Fuel Pump Pressure/Volume Test

1. Connect EFI Fuel Pressure Gauge T80L-9974-A and Adapter Hose T85L-9974-A to the schrader valve on the fuel supply manifold.



2. Start the engine. If the engine will not start proceed as follows:
   a. Remove the fuel pump relay from the circuit protection panel.
   b. Connect a jumper wire from relay terminal 87 in the panel to the alternator output terminal.



3. With the pump running, check the reading on the pressure gauge.

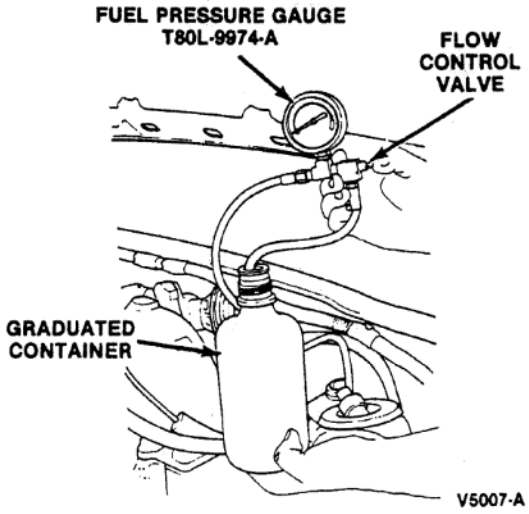
   If the fuel pressure reaches 241-310 kPa (35-45 psi), the pressure reading is within specifications. Proceed to the next Step.

   If the pressure reading is below specifications refer to the Fuel Pressure Diagnostic Chart in this Section.

4. Insert the test volume hose in a graduated container and open the flow control valve for ten seconds.

   If the pump delivers 7.5 ounces in ten seconds, the volume test is within specifications.

   If the volume test is below specification refer to the Fuel Pressure Diagnostic Chart in this Section.



5. Disconnect the jumper wire to stop the pumps and observe the pressure gauge.

   If the pressure holds at a minimum of 207 kPa (30 psi) the system is holding pressure.

   If pressure drops below the specified amount, refer to the Fuel Pressure Diagnostic Chart in this Section.

6. Install the fuel pump relay.

DIAGNOSTIC PROCEDURES (Continued)

DIAGNOSTIC CHART
FUEL PRESSURE

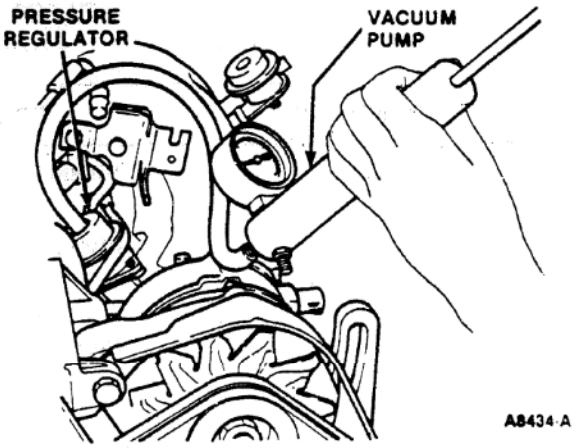
CONDITION	PROBABLE CAUSE	CORRECTIVE ACTION
Fuel Pressure Low	Kinked or bent fuel line	Inspect fuel lines and reroute or replace as required.
	Plugged fuel filter(s)	Remove and inspect filters. If necessary, refer to Section 24-51.
	Pressure regulator leaking	Test pressure regulator. If necessary, refer to diagnostic procedure in this section.
	Pump not operating properly	Replace pump. If necessary, refer to Section 24-35.
Fuel Pressure High	Pressure regulator not operating properly	Replace pressure regulator. If necessary, refer to Section 24-35.
	Kinked, bent or plugged fuel return line	Inspect return line and reroute or replace as required.
Fuel Volume Low	Kinked, plugged or bent fuel line	Inspect fuel lines and reroute or replace as required.
	Plugged fuel filter(s)	Remove and inspect filters. If necessary, refer to Section 24-51.
	Pump not operating properly	Replace pump. If necessary, refer to Section 24-35.
Fuel Pressure Does Not Hold	Pressure regulator leaking	Test pressure regulator. If necessary, refer to Diagnostic Procedure in this section.
	Leaks	Check for leaks at fuel lines, fittings and injectors. Repair as necessary.

V5478-A

DIAGNOSTIC PROCEDURES (Continued)

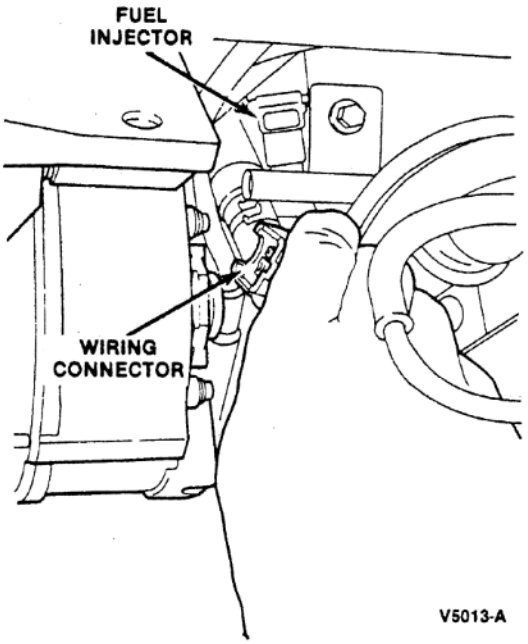
Pressure Regulator Check

Disconnect the vacuum line at the pressure regulator. Connect a hand-operated vacuum pump to the regulator fitting and apply 18 inches of vacuum. If the reading does not remain at 18 inches the regulator diaphragm is leaking. Replace the pressure regulator. If necessary, refer to Section 24-29.



Fuel Injector Functional Test

If the engine will not accelerate smoothly and idles roughly, a fuel injector may be inoperative. To check for a faulty injector, first bring the engine to operating temperature and then, with the engine idling disconnect and reconnect each injector while noting any change in idle speed. When a good injector is disconnected, idle speed should drop and then recover when the injector is disconnected. If an injector is disconnected and no change occurs in idle speed or quality, a faulty injector is indicated. To check the injectors, refer to the Fuel Injector Diagnosis Chart in this Section.



Fuel Injector Testing and Cleaning

To help diagnose EFI fuel injector problems use the following Troubleshooting Chart along with the Rotunda Fuel Injector Tester/Cleaner 113-00001.

The majority of fuel injector problems are due to clogged fuel injectors caused by fuel deposits. These injectors can be cleaned and restored back to their normal operating condition by using the following procedures.

If fuel injectors cannot be cleaned or have another of the listed problems, they must be tested before replacement.

DIAGNOSTIC PROCEDURES (Continued)

FUEL INJECTOR TROUBLESHOOTING CHART

For high pressure-high resistance and high pressure-low resistance ported EFI systems only.

SYMPTOM	FUEL INJECTOR FAILURE MODE	CAUSE	CORRECTIVE ACTION
Rough Idle	Lean Injector	Tip Deposits	Clean Injectors
		Internal Contamination	Test/Replace if Necessary
	Rich Injector	Stuck Open	Test/Replace if Necessary
	Injector Will Not Pulse	Short or Open Circuit	Test/Replace if Necessary
Misses Under Load Hesitates or Stalls on Acceleration Backfires Lacks Power Surges at Steady Speed	Lean Injector	Tip Deposits Internal Contamination	Clean Injectors Test/Replace if Necessary
Gas Smell	Injector Stuck Open	Internal Contamination	Test/Replace if Necessary
	Injector Leaks Internally (Into Intake Manifold)	Internal Contamination	Test/Replace if Necessary
	Injector Leaks Externally	Defective O-Rings	Test/Replace if Necessary

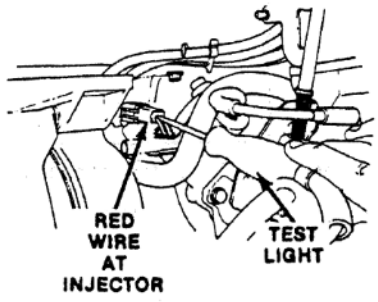
Note: Test and Clean Injectors Using the Rotunda Tester/Cleaner P/N 113-00001 CV7153-A

DIAGNOSTIC PROCEDURES (Continued)

DIAGNOSTIC CHART
FUEL INJECTOR

1 POWER FEED CIRCUIT CHECK

TEST STEP	RESULTS	ACTION TO TAKE
• Connect test light between red wire at injector and clean chassis ground and turn ignition switch to POSITION II (RUN) and watch test light.	Light on	Test results OK. Proceed to Test 2.
	Light off	Test results not OK. Repair open in power feed circuit to injector.



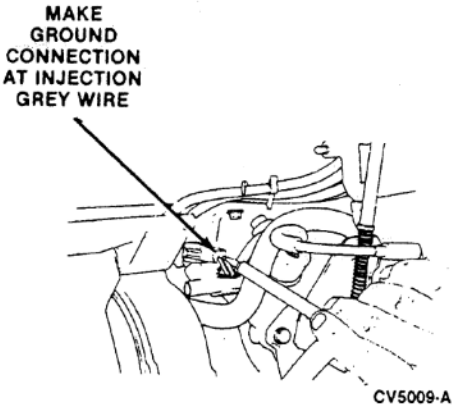
CV5009-A1

DIAGNOSTIC PROCEDURES (Continued)

DIAGNOSTIC CHART
FUEL INJECTOR (Continued)

2 INJECTOR FUNCTIONAL CHECK

TEST STEP	RESULTS	ACTION TO TAKE
• Connect one end of jumper wire to clean chassis ground and turn ignition switch to POSITION II (RUN). Using jumper wire ground, tan wire at injector. Listen and feel for injector click.	Injector clicks	Test results OK. Proceed to Test 3.
	Injector does not click	Test results not OK. Replace injector. With this repair, injector should operate.



3 CONTROL CIRCUIT CONTINUITY CHECK

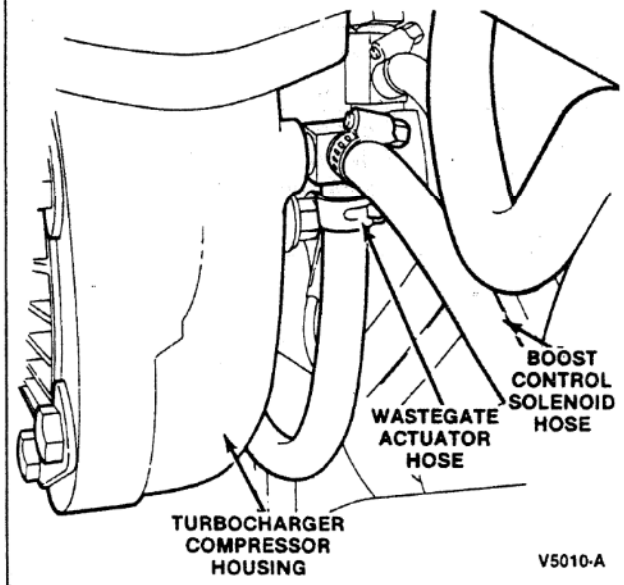
• Using an ohmmeter, check for continuity between injector tan wires and wires connected to pins 58 and 59 at ECA.	Continuity	Test results OK. Problem does not seem to be in injectors. Refer to Engine/Emission Diagnosis at the back of this Shop Manual to check operation of ECA or return to Trouble-shooting Chart for further diagnosis.
	No continuity	Repair open in ECA control circuit. With this repair injector(s) should operate.

CV7152-A

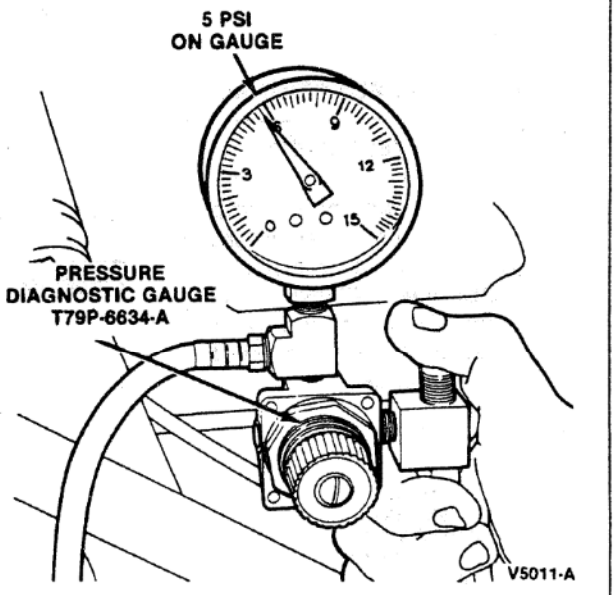
DIAGNOSTIC PROCEDURES (Continued)

Turbocharger Wastegate Actuator Check

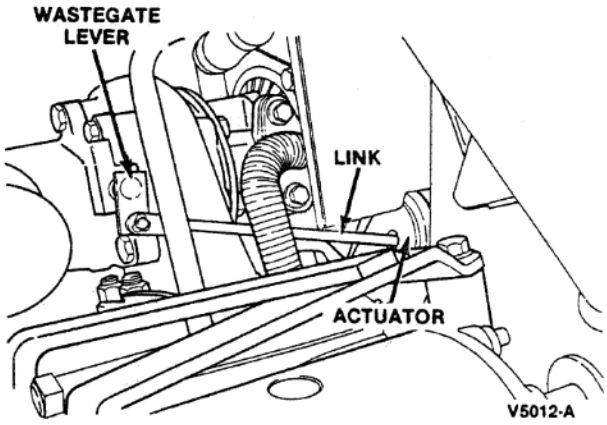
1. Disconnect the wastegate actuator hose at the turbocharger fitting.



2. Connect Pressure Diagnostic Gauge T79P-6634-A to the actuator hose.
3. Apply 69 kPa (10 psi) to the actuator and trap. If the pressure drops below 14 kPa (2 psi) after two minutes, replace the turbocharger assembly.



4. Release the pressure from the actuator and raise the vehicle.
5. While applying 34 kPa (5 psi) to the wastegate actuator, watch the actuator link and wastegate lever. The link should rotate the lever smoothly when the 34 kPa (5 psi) is applied. If the lever and link do not operate properly, replace the turbocharger assembly.

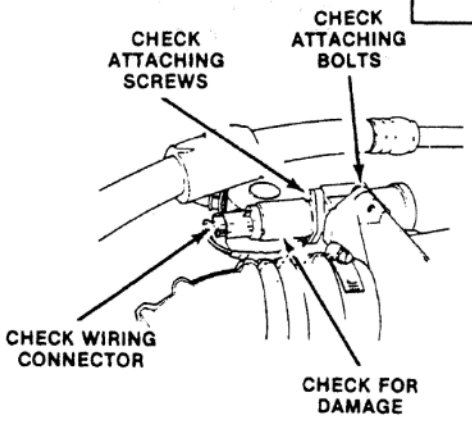


DIAGNOSTIC PROCEDURES (Continued)

DIAGNOSTIC CHART
IDLE SPEED CONTROLLER

1 INSPECTION

TEST STEP	RESULTS	ACTION TO TAKE
• Check wiring and controller for damage or deterioration.	No repairs required	Test results OK. Proceed to Test 2.
	Repairs required	Test results not OK. Repair as required. With this repair, controller should operate.



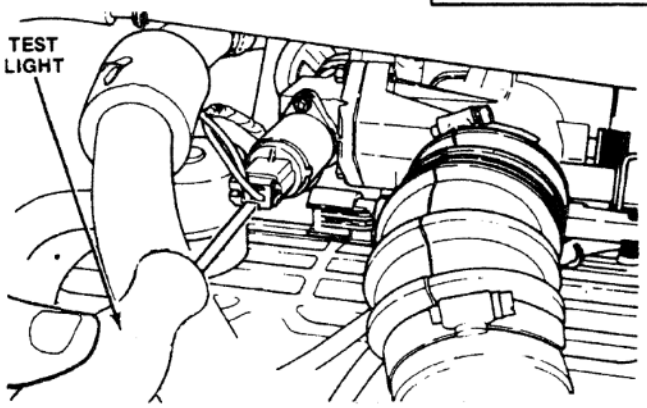
CV5014-A1

DIAGNOSTIC PROCEDURES (Continued)

DIAGNOSTIC CHART
IDLE SPEED CONTROLLER (Continued)

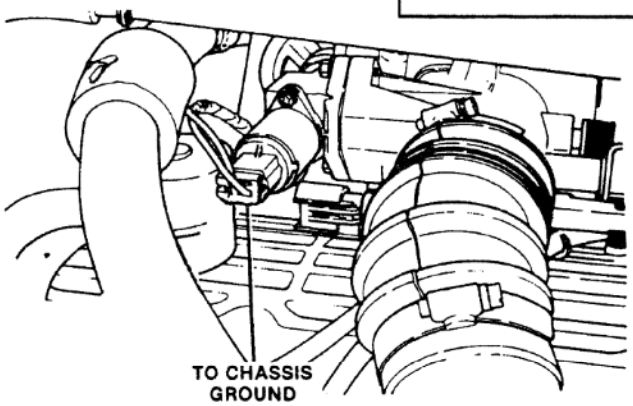
2 POWER FEED TO ACTUATOR CHECK

TEST STEP	RESULTS	ACTION TO TAKE
• Connect test light between red wire and clean chassis ground and turn ignition switch to POSITION II (RUN) and watch test light.	Light on	Test results OK. Proceed to Test 3.
	Light off	Test results not OK. Repair open in power feed circuit. With this repair, controller should operate.



3 CONTROLLER OPERATIONAL CHECK

• Connect jumper wire from actuator grey wire to a clean chassis ground and turn ignition switch to POSITION II (RUN) and listen for controller operation.	Controller operates	Test results OK. Proceed to Test 4.
	Controller does not operate	Test results not OK. Replace idle speed controller. With this repair, controller should operate.



CV5014-A2

DIAGNOSTIC PROCEDURES (Continued)

DIAGNOSTIC CHART — IDLE SPEED CONTROLLER (Continued)

4 CONTROL CIRCUIT CHECK

TEST STEP	RESULTS	ACTION TO TAKE
Using an ohmmeter check for continuity between wire at ECA pin 21 and grey wire at controller.	Continuity	Test results OK. Problem does not seem to be in idle speed control controller. Refer to Group H located at the back of this Shop Manual to check operation of ECA or return to Troubleshooting Chart for further diagnosis.

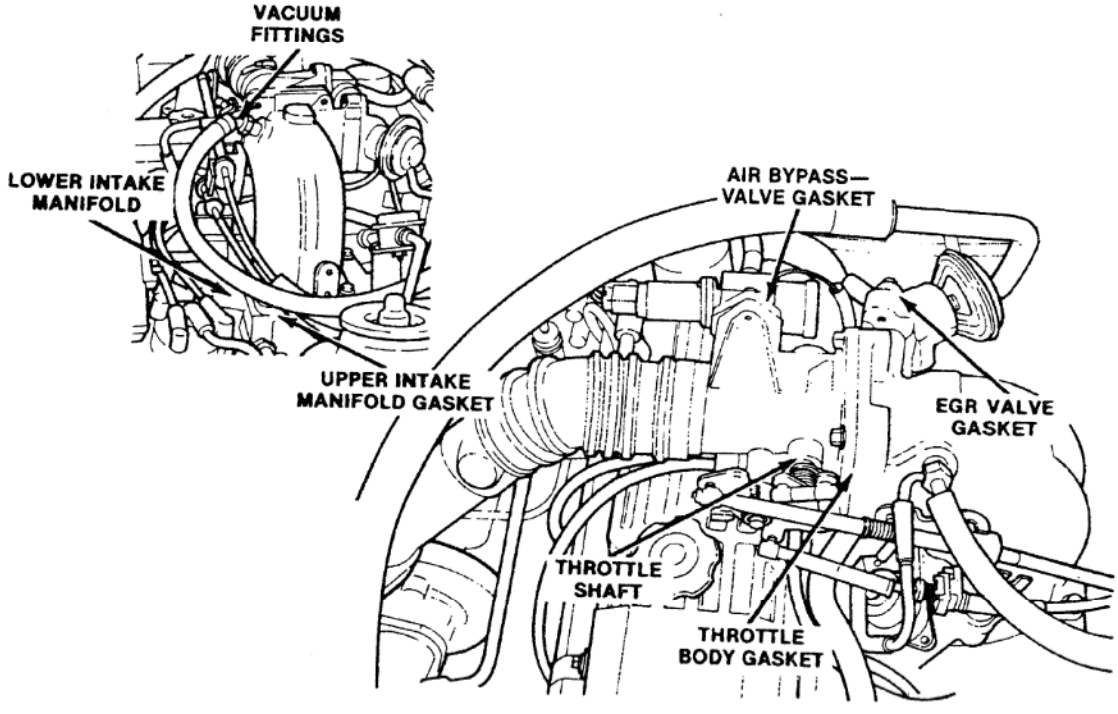
CV7155-A

Air Leak Check

Air leaks in the components of the fuel charging assembly can affect engine idle and engine performance. To check for these leak(s), bring the engine to operating temperature and connect a tachometer. Using a petroleum based aerosol cleaner with a directional tube, spray the following gasketed connection points and check for any change in engine rpm:

- Lower intake manifold to cylinder head.
- Upper intake manifold to lower intake manifold.
- Throttle body to upper intake manifold.
- Throttle body shaft area.
- Air bypass valve to throttle body.
- EGR valve gasket.

If idle speed changes when any specific area is sprayed, a gasket leak is indicated. If necessary, refer to the appropriate fuel system section for component removal and gasket replacement.



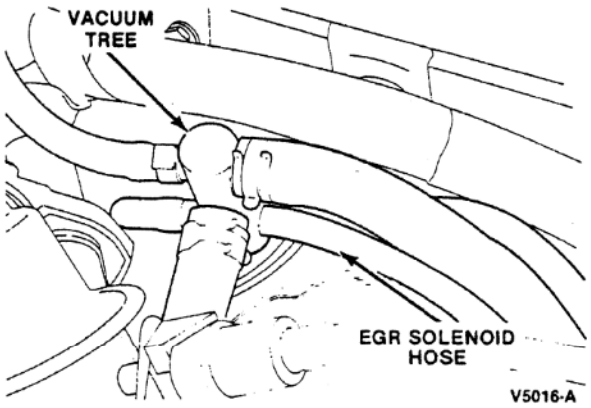
V5015-B

DIAGNOSTIC PROCEDURES (Continued)

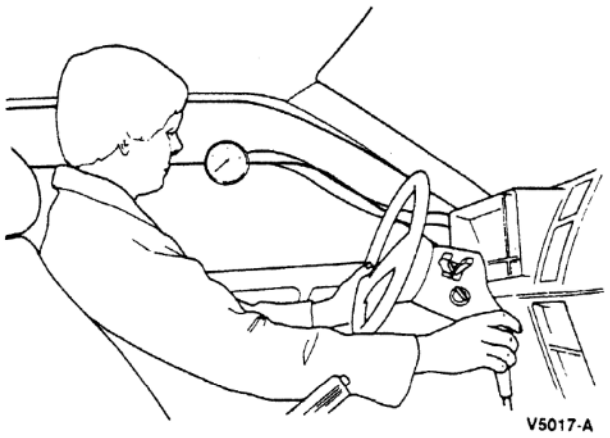
Turbocharger Functional Check

CAUTION: If the turbocharger overboost warning buzzer comes on during the test, immediately release the throttle to prevent serious engine damage.

1. Disconnect the EGR solenoid hose at the vacuum tree located to the right of the brake power booster in the engine compartment.



2. Between the vacuum tree and EGR solenoid hose, tee-in a compound gauge. Make sure the gauge hose is long enough to reach the passenger compartment.
3. With conditions and speed limits permitting, accelerate at wide-open throttle from zero to 64 or 84 kph (40 or 50 mph) and observe the compound gauge.
   - Turbocharger boost is within specification if it is 103 kPa (13 psi) for an automatic transmission equipped vehicle or 89 kPa (15 psi) for a manual transmission equipped vehicle.
   - If the turbocharger boost is above or below specifications, return to the Troubleshooting Chart for further diagnosis.

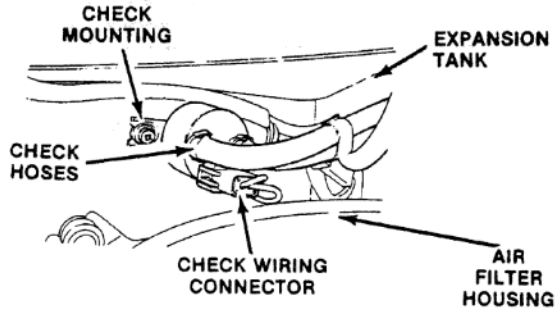


DIAGNOSTIC PROCEDURES (Continued)

DIAGNOSTIC CHART
BOOST CONTROL SOLENOID

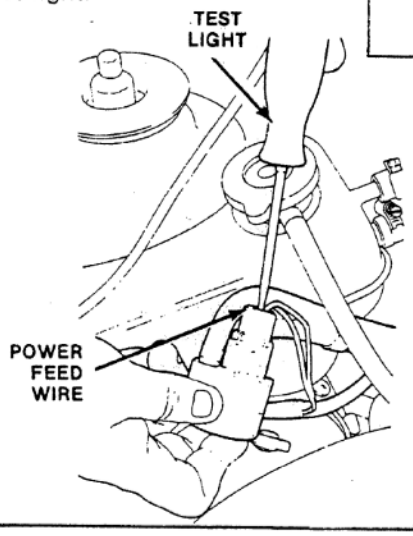
1 INSPECTION

TEST STEP	RESULTS	ACTION TO TAKE
• Inspect wiring and hoses for proper connection and check hoses for leaks or deterioration.	No repairs required	Test results OK. Proceed to Test 2.
	Repairs required	Test results not OK. Repair as required. With this repair, solenoid should operate.



2 POWER FEED TO SOLENOID CHECK

• Connect test light between red wire and clean chassis ground and turn ignition switch to POSITION II (RUN) and watch test light.	Light on	Test results OK. Proceed to Test 3.
	Light off	Test results not OK. Repair open in power feed circuit. With this repair, solenoid should operate.



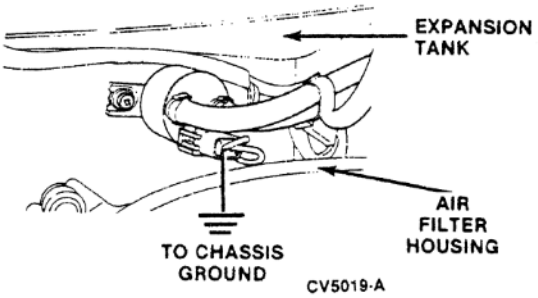
CV5019-A1

DIAGNOSTIC PROCEDURES (Continued)

DIAGNOSTIC CHART
BOOST CONTROL SOLENOID (Continued)

3 SOLENOID OPERATIONAL CHECK

TEST STEP	RESULTS	ACTION TO TAKE
• Connect jumper wire from solenoid purple wire to a clean chassis and listen for solenoid click. Turn ignition switch to RUN position.	Solenoid clicks	Test results OK. Proceed to Test 4.
	Solenoid does not click	Replace boost control solenoid. With this repair, solenoid should operate.



4 CONTROL CIRCUIT CHECK

Using an ohmmeter, check for continuity between wire at ECA pin 32 and purple wire at solenoid.	Continuity	Test results OK. Proceed to Test 5.
	No continuity	Repair open in ECA control circuit. With this repair, solenoid should operate.

5 SOLENOID FUNCTIONAL CHECK

• Disconnect solenoid hose at turbocharger and PCV fittings and plug the PCV hose. Using a hand-operated pump, apply vacuum through the turbocharger hose and see if it holds.	Vacuum holds	Test results OK. Problem does not seem to be in turbo-boost solenoid. Refer to Group H located at the back of this Shop Manual to check operation of ECA or return to Troubleshooting Chart for further diagnosis.

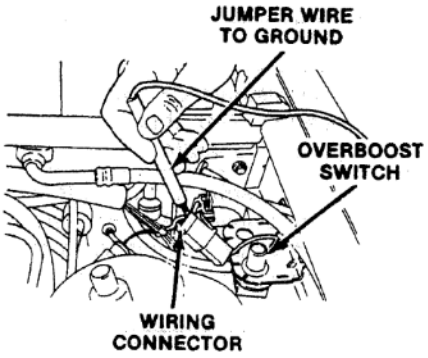
CV7156-A

DIAGNOSTIC PROCEDURES (Continued)

DIAGNOSTIC CHART
OVERBOOST WARNING SWITCH

1 BUZZER OPERATIONAL CHECK

TEST STEP	RESULTS	ACTION TO TAKE
Connect jumper wire from switch connector to clean chassis ground.	Buzzer sounds	Test results OK. Proceed to Test 4.
	Buzzer does not sound	Test results not OK. Proceed to Test 2.



2 BUZZER TO SWITCH CONTINUITY CHECK

• Separate the wiring connectors at the overboost switch and buzzer. Using an ohmmeter, check for continuity in circuit 31-14 (BR/Y)—buzzer connector to switch connector.	Continuity	Test results OK. Proceed to Test 3.
(Note the overboost buzzer is located behind the right side of the instrument panel.)	No continuity	Test results not OK. Repair open in circuit. With this repair buzzer should operate. Return to Test 1 to verify.

3 POWER FEED TO BUZZER CHECK

Using a test light, check for battery voltage at buzzer power feed terminal—circuit 54-14 R/BL.	Light on	Test results OK. Replace buzzer. With this repair, buzzer should operate.
	Light off	Test results not OK. Repair open in power feed circuit. With this repair, buzzer should operate.

CV5018-A1

DIAGNOSTIC PROCEDURES (Continued)

DIAGNOSTIC CHART
OVERBOOST WARNING SWITCH (Continued)

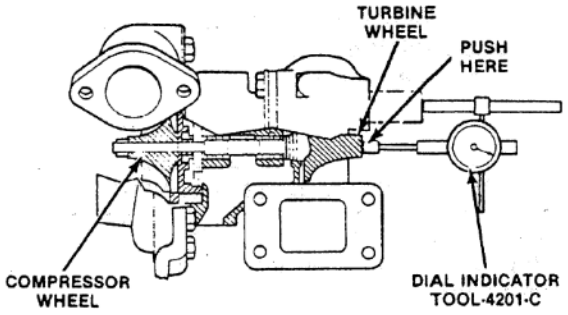
4 GROUND WIRE INSPECTION

TEST STEP	RESULTS	ACTION TO TAKE
Inspect ground wire from bottom of switch to bracket for damage or poor connection.	Ground wire OK	Test results OK. Proceed to Test 5.
	Ground wire not OK	Repair as required. With this repair, buzzer should operate.
5 GROUND CIRCUIT CHECK		
Using an ohmmeter, check for continuity between the switch bracket and a clean chassis ground.	Continuity	Test results OK. Replace switch. With this repair, buzzer should operate.
	No continuity	Test results not OK. Clean surface between bracket and body to provide ground. With this repair buzzer should operate.

CV5018-A2

Turbocharger Bearing Axial Clearance Check

1. Remove the turbocharger assembly from the engine. If necessary, refer to Section 24-29.
2. Remove the five bolts connecting the turbine outlet elbow assembly and remove the elbow.
3. Attach Dial Indicator TOOL 4201-C, or equivalent, to the center housing so that the indicator plunger contacts the shaft.
4. Manually push the turbine wheel assembly as far away from dial indicator tip as possible.
5. Set the dial indicator to zero while holding the turbine wheel away from the plunger tip.
6. Manually push the turbine wheel assembly toward the dial indicator tip as far as possible.
7. Repeat Step 4 to make sure the dial indicator returns to zero.
8. Repeat Steps 4, 5, 6 and 7 to make sure an accurate measurement has been made. If the bearing axial clearance is less than 0.025mm (0.001 inch) or greater than 0.076mm (0.003 inch), replace the turbocharger assembly.

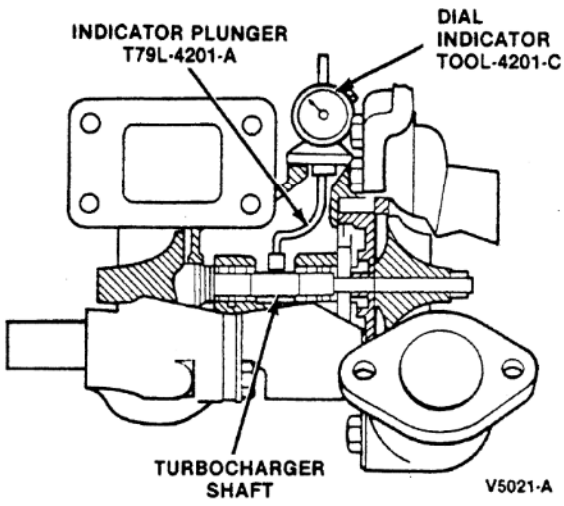


V5020-A

DIAGNOSTIC PROCEDURES (Continued)

Turbocharger Bearing Radial Clearance Check

1. Remove the turbocharger assembly from the engine.
2. Remove the wastegate actuator rod retaining clip and disconnect the rod from the wastegate arm.
3. Attach Dial Indicator TOOL 4201-C or equivalent to the center housing so that the indicator Plunger T79L-4201-A, or equivalent, extends through the oil outlet port and contacts the shaft.
4. Manually apply pressure equally and simultaneously to both the compressor and turbine wheels to move the shaft away from the dial indicator plunger as far as it will go.
5. Set the dial indicator to zero while holding the shaft away from the plunger tip.
6. Manually apply pressure equally and simultaneously to both the compressor and turbine wheels to move the shaft toward the dial indicator plunger as far as it will go.
7. Repeat Step 5 to make sure the dial indicator returns to zero.
8. Repeat Steps 5, 6, 7 and 8 to make sure an accurate measurement has been made. If the bearing radial clearance is less than 0.076mm (0.003 inch) or greater than 0.152mm (0.006 inch), replace the turbocharger assembly.



SECTION 24-29 FUEL INJECTION

CONTENTS

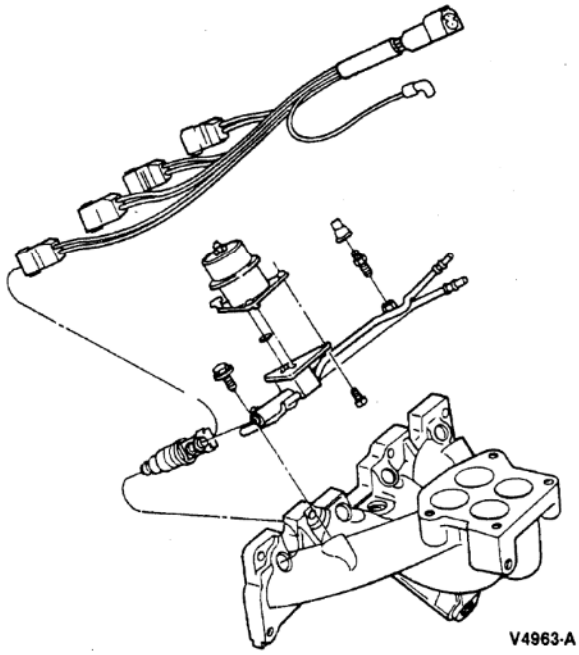
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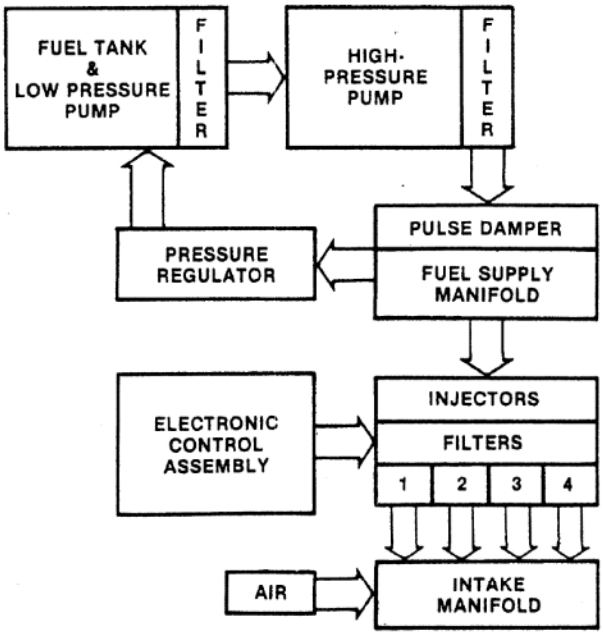
DESCRIPTION

GENERAL INFORMATION

The Electronic Fuel Injection system (EFI) is classified as a multi-point, pulse time, mass air flow, fuel injection system. Fuel is metered into the intake air stream in accordance with engine demand through four injectors mounted on a tuned intake manifold.

An on-board vehicle electronic engine control (EEC-IV) computer accepts inputs from various engine sensors to compute the required fuel flow rate necessary to maintain a prescribed air/fuel ratio throughout the entire engine operational range. The computer then outputs a command to the fuel injectors to meter the required quantity of fuel.

The EEC-IV engine control system automatically senses and compensates for changes in altitude (i.e., from sea level to mountains) and will also permit push-starting the vehicle should it become necessary (manual transmission only).



V4964-A

DESCRIPTION

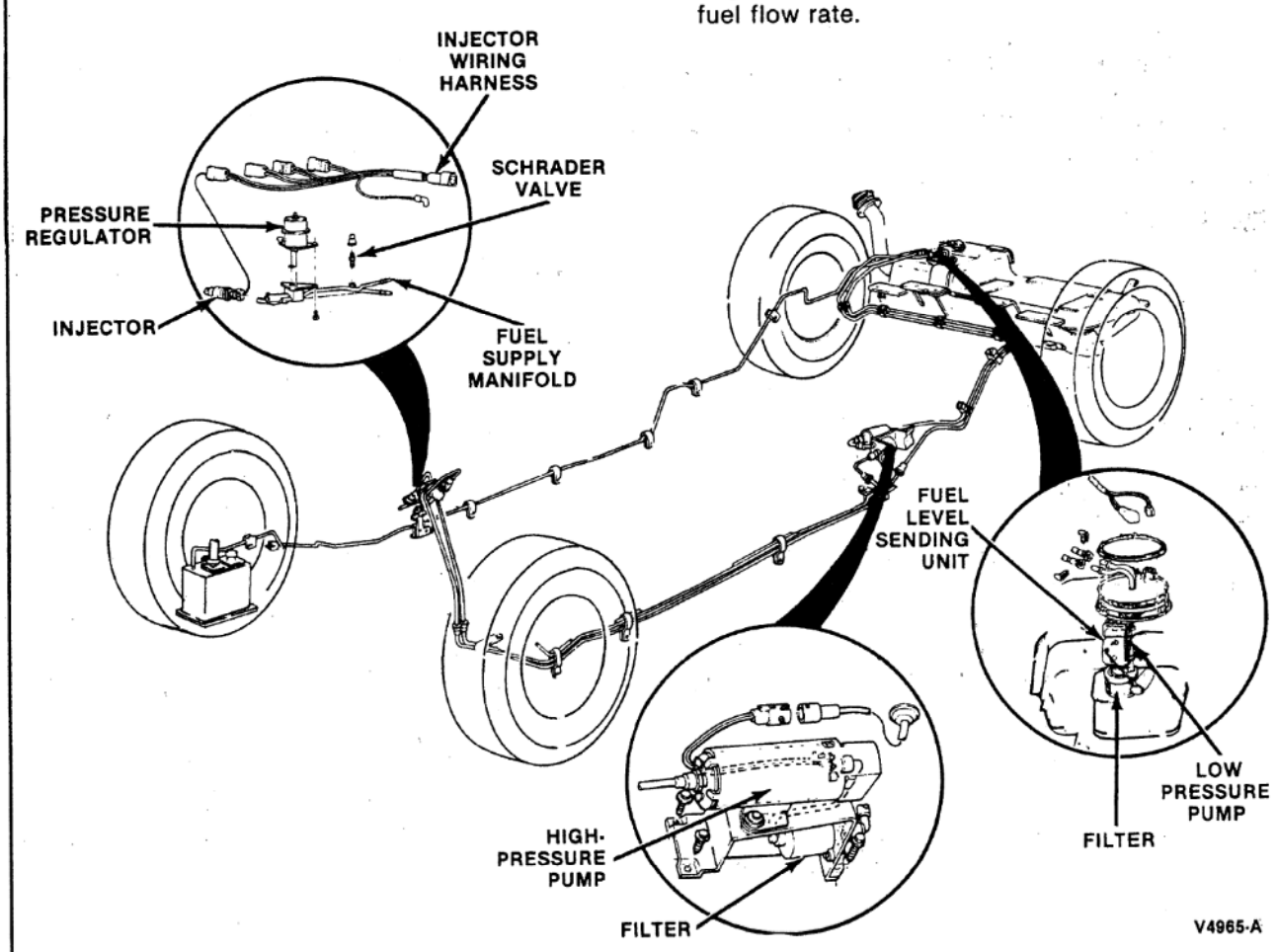
GENERAL INFORMATION (Continued)

The fuel delivery subsystem consists of an in-tank low-pressure pump, a high-pressure chassis-mounted electric fuel pump and the necessary interconnecting tubing. Fuel drawn from the tank passes through a filter before entering the low-pressure pump. The fuel is filtered again as it leaves the high-pressure pump on its way to the pulse damper and fuel supply manifold. The pulse damper smooths the pressure variations generated by the opening and closing of the fuel injectors

The fuel supply manifold assembly incorporates electrically actuated fuel injectors directly above each of the engine's four intake ports. The injectors, when energized, spray a metered quantity of fuel into the intake air stream.

A constant fuel pressure drop is maintained across the injector nozzles by a pressure regulator. The regulator is connected in series with the fuel injectors and is positioned downstream from them. Excess fuel supplied by the pump, but not required by the engine, passes through the regulator and returns to the fuel tank through a fuel return line.

Two injectors are energized simultaneously, once every crankshaft revolution. The period of time that the injectors are energized (injector "on time" or pulse width) is controlled by the vehicles' Electronic Engine Control (EEC) computer. Air entering the engine is measured by a vane air flow meter located between the air cleaner and the turbocharger. The air flow is then compressed by the turbocharger before introduction into the intake manifold. This air flow information along with input from various other engine sensors is used to compute the required fuel flow rate.

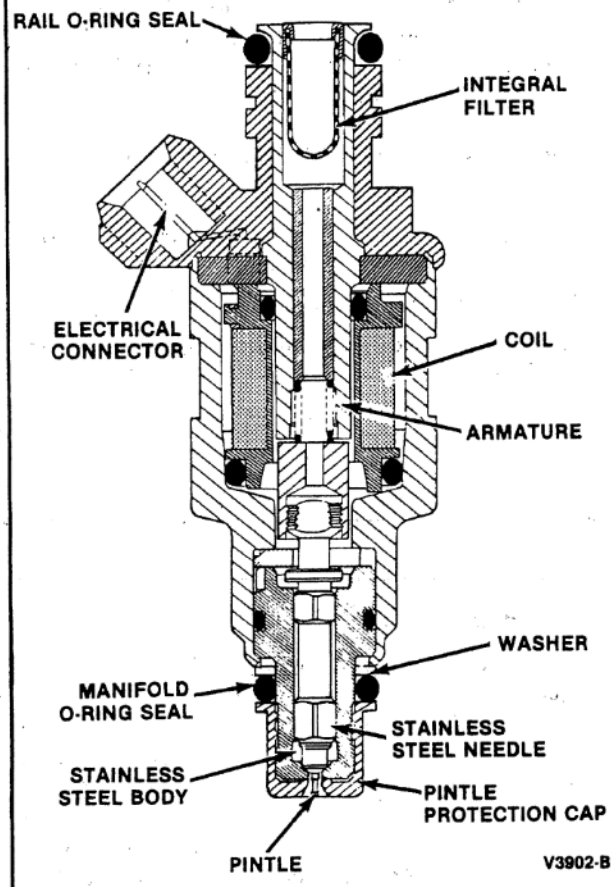


DESCRIPTION

COMPONENTS

Fuel Injectors

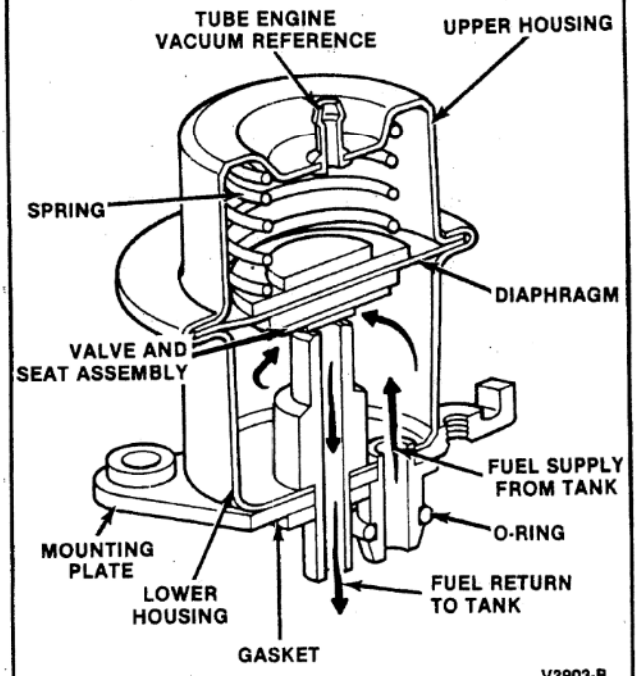
The four fuel injector nozzles are electro-mechanical devices which both meter and atomize fuel delivered to the engine. The injectors are mounted in the lower intake manifold and are positioned so that their tips direct fuel just ahead of the engine intake valves. The injector bodies consist of a solenoid actuated pintle and



needle valve assembly. An electrical control signal from the Electronic Engine Control unit activates the injector solenoid, causing the pintle to move inward off the seat, allowing fuel to flow. Since the injector flow orifice is fixed and the fuel pressure drop across the injector tip is constant, fuel flow to the engine is regulated by how long the solenoid is energized. Atomization is obtained by contouring the pintle at the point where the fuel separates.

Fuel Pressure Regulator

The fuel pressure regulator is attached to the fuel supply manifold assembly downstream of the fuel injectors. It regulates the fuel pressure supplied to the injectors. The regulator is a diaphragm-operated relief valve in which one side of the diaphragm senses fuel pressure and the



other side is subjected to intake manifold pressure. The nominal fuel pressure is established by a spring preload applied to the diaphragm. Balancing one side of the diaphragm with manifold pressure maintains a constant fuel pressure drop across the injectors. Fuel, in excess of that used by the engine, is bypassed through the regulator and returns to the fuel tank.

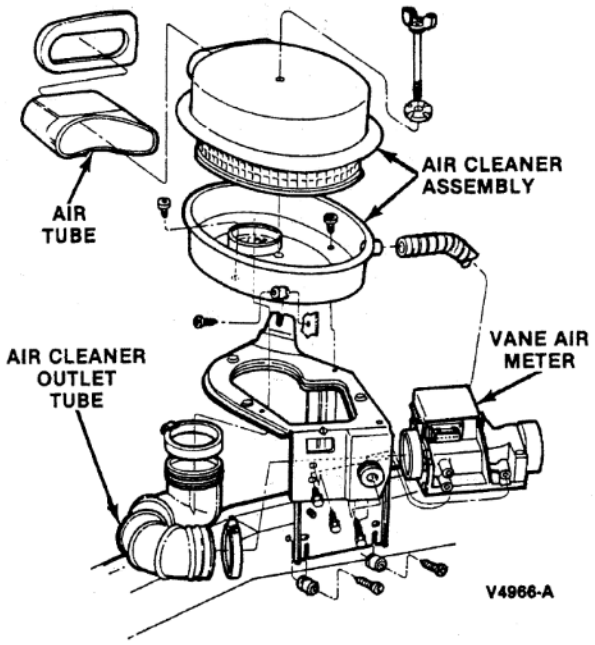
Fuel Supply Manifold Assembly

The fuel supply manifold assembly delivers high-pressure fuel from the vehicle fuel supply line to the four fuel injectors. The assembly consists of a single, preformed tube or stamping with four injector connectors, a mounting flange to the fuel pressure regulator and mounting attachments which locate the fuel manifold assembly and provide fuel injector retention.

DESCRIPTION

Vane Air Meter Assembly

The vane air meter assembly is mounted on a bracket immediately below the air cleaner in the lower right hand corner of the engine compartment. The vane air meter contains two sensors which furnish input to the Electronic Control Assembly: an airflow sensor and a vane air temperature sensor. The vane air meter measures the volume of air flow to the engine. Air flow through the body moves a vane mounted on a pivot pin. This vane is connected to a variable resistor (potentiometer) which in turn is connected to a 5-volt reference voltage. The output of this potentiometer varies depending on the volume of air flowing through the sensor. The temperature sensor in the air vane meter measures the incoming air temperature. The air volume and temperature inputs are used by the Electronic Control Assembly to compute the fuel flow (injector pulse duration) necessary for the optimum air/fuel ratio.



Throttle Body Assembly

The throttle body assembly controls air flow to the engine through a single butterfly-type valve. The throttle position is controlled by multiple-link, progressive opening, throttle linkage. The body is a single-piece die casting made of aluminum. It has a single bore with an air bypass channel around the throttle plate. This bypass channel controls both cold and warm engine idle airflow as regulated by an air bypass valve assembly mounted directly to the throttle body. The valve assembly is an electro-mechanical device controlled by the EEC computer. It incorporates a linear actuator which positions a variable area metering valve.

Other features of the air throttle body assembly include:

1. An adjustment screw to set the throttle plate at minimum idle airflow position.
2. A preset stop to locate the WOT position.
3. A throttle body mounted throttle position sensor.

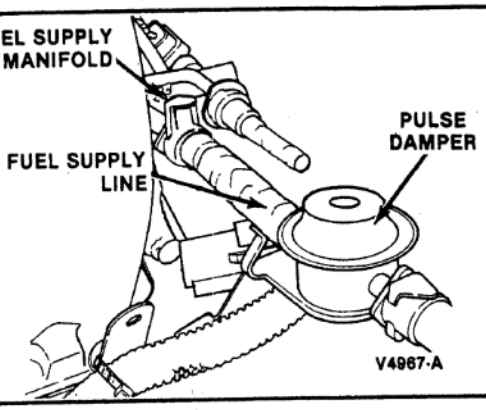
Air Intake Manifold

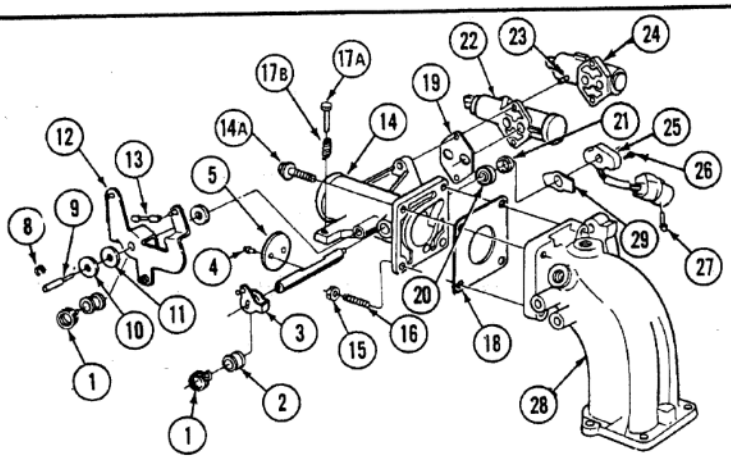
The air intake manifold is a two-piece (upper and lower intake manifold) aluminum casting. Runner lengths are tuned to optimize engine torque and power output. The manifold provides mounting flanges for the air throttle body assembly, fuel supply manifold and accelerator control bracketry and the EGR valve and supply tube. Vacuum taps are provided to support various engine accessories. Pockets for the fuel injectors are machined to prevent both air and fuel leakage. The pockets, in which the injectors are mounted, are placed to direct the injector fuel spray immediately in front of each engine intake valve.

DESCRIPTION

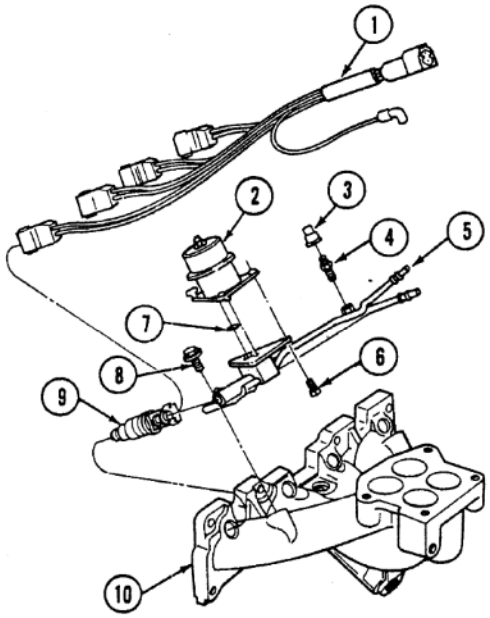
Pulse Damper

The opening and closing of the fuel injectors generates pulses in the fuel supply manifold. These pulses or pressure variations are smoothed by the pulse damper. The damper is mounted on a bracket behind the upper intake manifold between the fuel supply line and the fuel supply manifold.





ITEM	PART NUMBER	PART NAME
1	9B569	SPRING — CARBURETOR THROTTLE RETURN
2	9F569	BUSHING — ACCELERATOR PUMP OVERTRAVEL SPRING (2)
3	9583	LEVER — ENGINE THROTTLE
4	N603076-S100	SCREW — M4 X .7 X 8
5	9E950	PLATE — AIR INTAKE CHARGE THROTTLE
6	9E951	SHAFT — AIR INTAKE CHARGE THROTTLE
7	9B569	SPRING — SECONDARY THROTTLE RETURN
8	N663109	E-RING
9	9N747	HUB — THROTTLE CONTROL
10	9N778	SPACER
11	9N744	WASHER — NYLON (2)
12	9583	LEVER — THROTTLE CONTROL
13	9C799	ROD — ENGINE SECONDARY THROTTLE CONTROL
14	9E927	BODY — AIR INTAKE CHARGE THROTTLE
14A	N605788-S36	BOLT M8 X 1.25 X 30 HEX FLANGE HEAD (2 REQ'D)
15	N80013-S52	NUT — M8 (2 REQ'D)
16	N802411-S100	STUD — M8 X 42.5 (2 REQ'D)
17A	374832	SCREW THROTTLE STOP
17B	5752152	SPRING — THROTTLE RETURN CONTROL
18	9E936	GASKET — AIR CHARGE CONTROL TO INTAKE MANIFOLD
19	9F670	GASKET — AIR BYPASS VALVE
20	9C753	SEAL — THROTTLE CONTROL SHAFT
21	9B508	BUSHING — CARBURETOR THROTTLE SHAFT
22	9F715	VALVE ASSEMBLY — THROTTLE AIR BYPASS
23	N605773-S100	BOLT — M6 X 1.0 X 20 HEX HEAD FLANGE
24	9F715	VALVE ASSEMBLY — THROTTLE AIR BYPASS (ALT.)
25	9B989	POTENTIOMETER THROTTLE POSITION
26	N800885-S52	SCREW AND WASHER ASSEMBLY M4 X 22
27	N611133-S51	SCREW — M4 X 0.7 X 14.0 HEX. WASHER TAP
28	9425	MANIFOLD — INTAKE UPPER
29	9F782	GASKET T.P.S.



ITEM	PART NUMBER	PART NAME
1	9D930	WIRING HARNESS — FUEL CHARGING
2	9C968	REGULATOR ASSEMBLY — FUEL PRESSURE
3	9H323	CAP — FUEL PRESSURE RELIEF
4	9H321	VALVE ASSEMBLY — FUEL PRESSURE RELIEF
5	9D280	MANIFOLD ASSEMBLY — FUEL INJECTION FUEL SUPPLY
6	N802353-S100	SCREW — M5 X 0.8 X 10 SOCKET HEAD (3 REQ'D)
7	87006-S96	SEAL — 5/16 X .070 O-RING
8	N605786-S2	BOLT (2 REQ'D)
9	9F593	INJECTOR ASSEMBLY — FUEL (4 REQ'D)
10	9K461	MANIFOLD — INTAKE LOWER

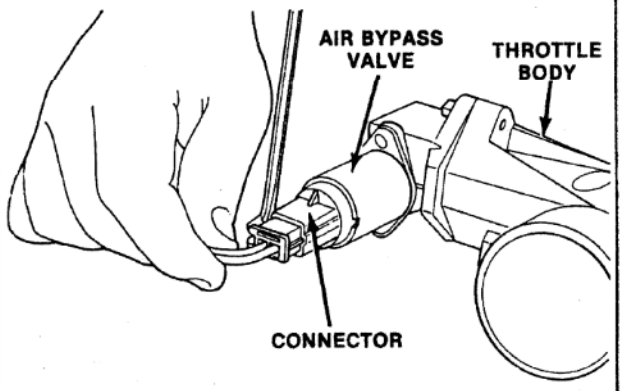
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REMOVAL AND INSTALLATION

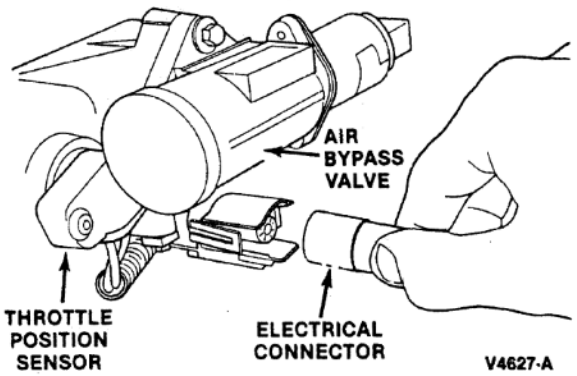
THROTTLE BODY

Removal (Continued)

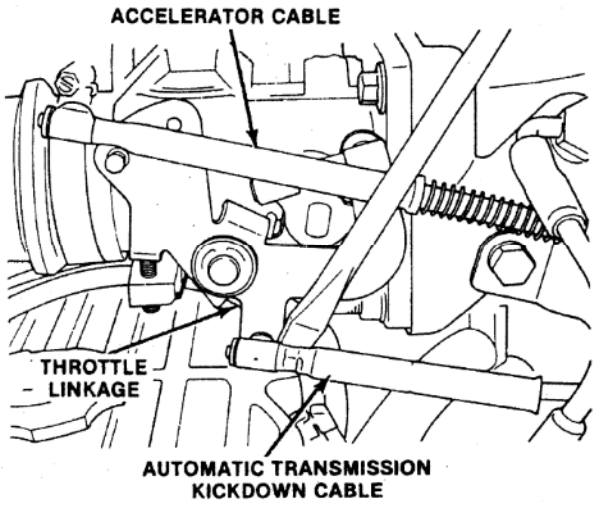
1. Disconnect the negative battery cable.
2. Disconnect the air bypass valve electrical connector.



3. Disconnect the throttle position sensor connector.

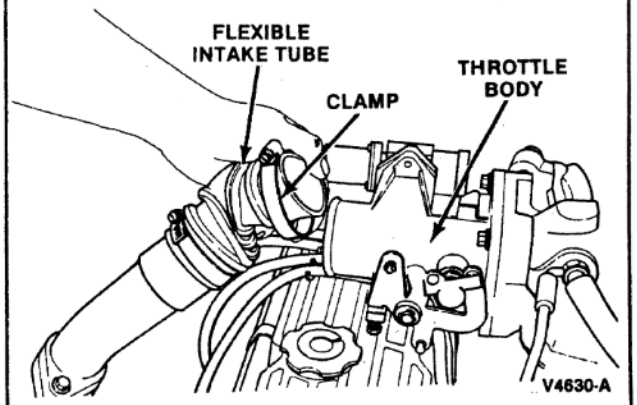


4. Disconnect the automatic transmission kickdown cable from the throttle linkage (if equipped).



5. Disconnect the accelerator cable from the throttle linkage.

6. Loosen the clamp and disconnect the flexible intake tube from the throttle body.

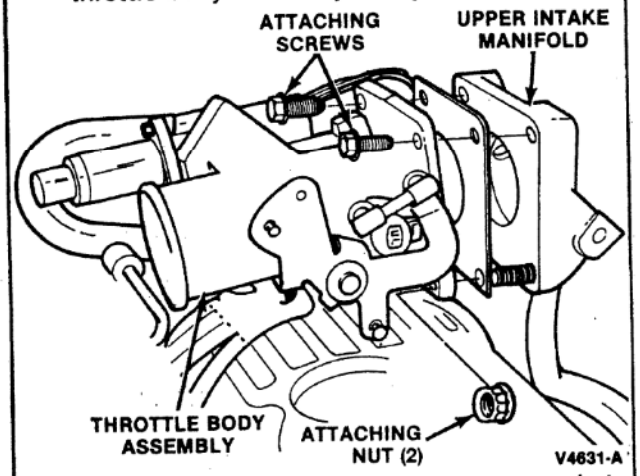


REMOVAL AND INSTALLATION

THROTTLE BODY

Removal (Continued)

7. Remove two upper attaching screws and two lower attaching nuts and remove the throttle body assembly and gasket.



NOTE: If it is necessary to scrape gasket material off of the throttle body or upper intake manifold, be careful not to damage the gasket surfaces or allow gasket material to drop into the manifold.

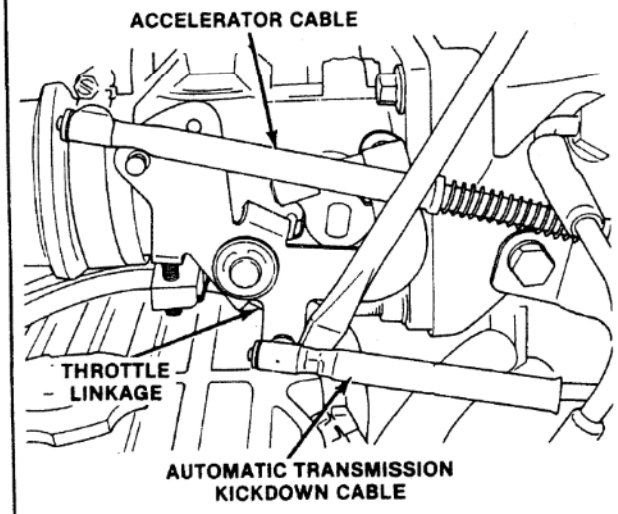
Installation

1. Make sure that both the throttle body and the upper intake manifold gasket surfaces are clean.
2. Install a new gasket, the throttle body, and the attaching screws and nuts. Tighten the screws and nuts to 16 to 20 N·m (12-15 lb-ft).
3. Connect the flexible intake tube to the throttle body and tighten the clamp.
4. Connect the accelerator cable to the throttle linkage.
5. Connect the automatic transmission kickdown cable, if so equipped, to the throttle linkage.
6. Connect the air bypass valve electrical connector.
7. Connect the throttle position sensor electrical connector.
8. Connect the battery negative cable.

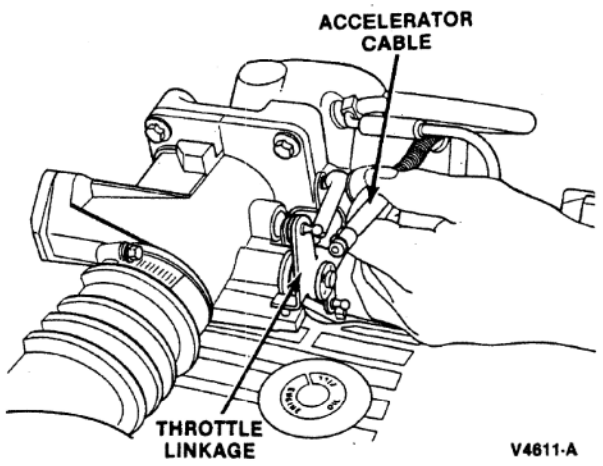
UPPER INTAKE MANIFOLD

Removal

1. If the vehicle is equipped with an automatic transmission, disconnect the automatic transmission kickdown cable from the throttle linkage.



2. Disconnect the accelerator cable from the throttle linkage.

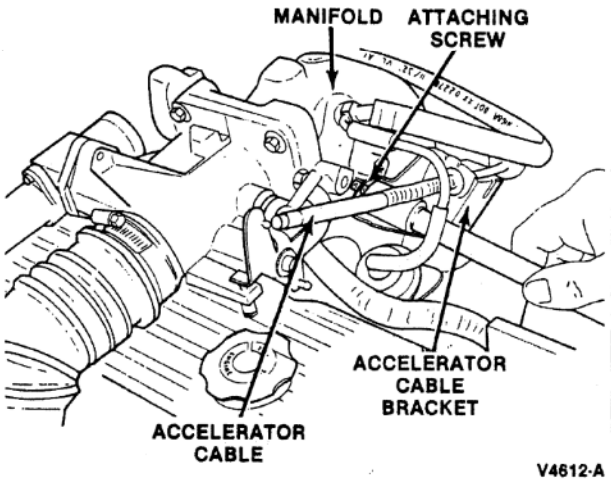


REMOVAL AND INSTALLATION

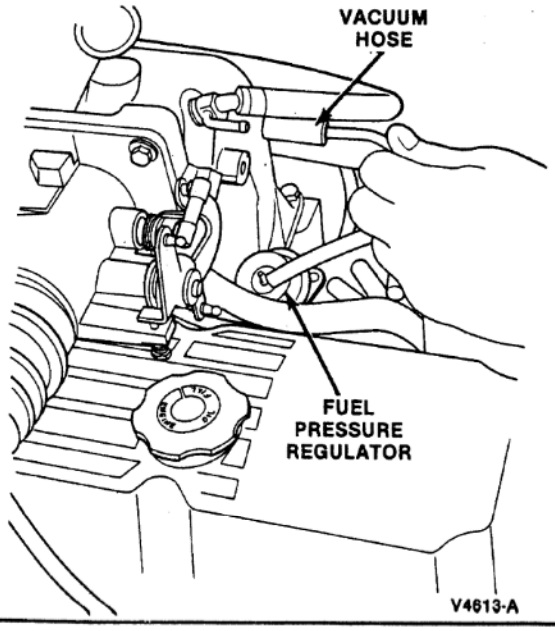
UPPER INTAKE MANIFOLD

Removal (Continued)

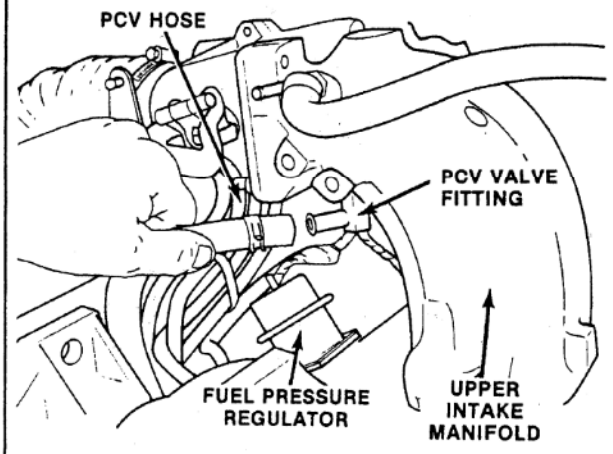
3. Remove the accelerator cable bracket attaching screws and the bracket from the upper intake manifold. Place the bracket and the accelerator cable (and the automatic transmission kickdown cable, if so equipped) aside.



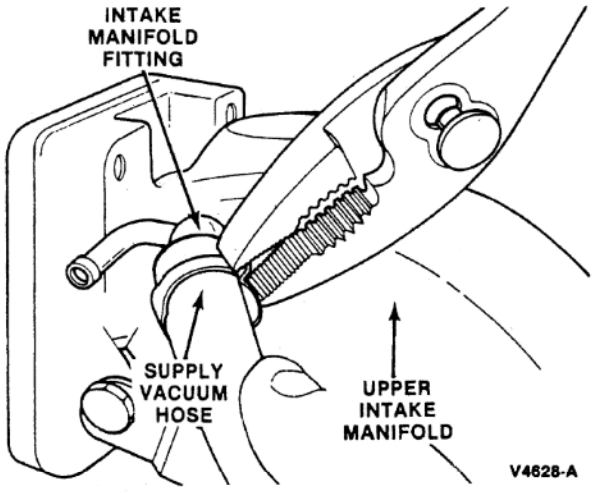
4. Disconnect the fuel pressure regulator vacuum hose at the intake manifold fitting.



5. Disconnect the PCV hose at the intake manifold fitting.

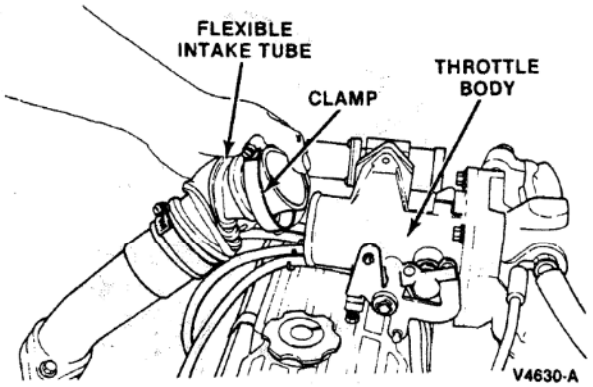


6. Disconnect the vacuum tree supply hose at the intake manifold fitting.

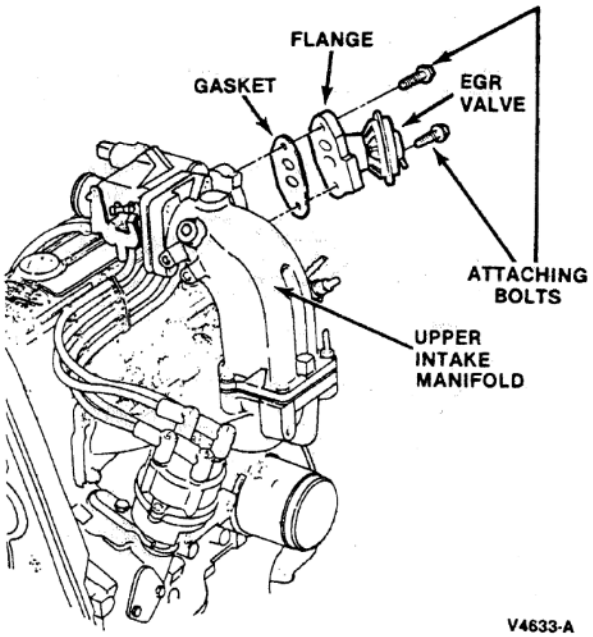


REMOVAL AND INSTALLATION (Continued)

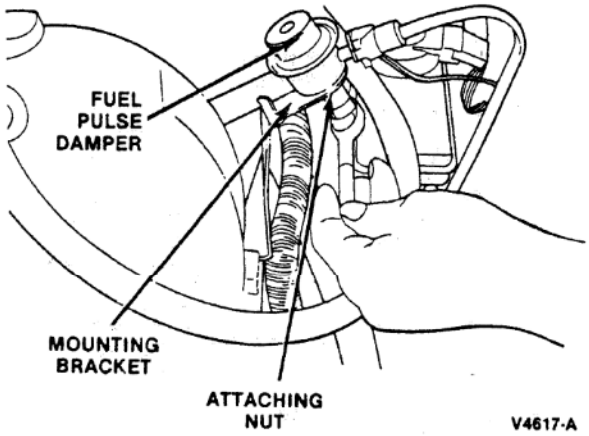
7. Loosen the hose clamps and remove the turbocharger outlet hose.



8. Remove the EGR flange attaching bolts.

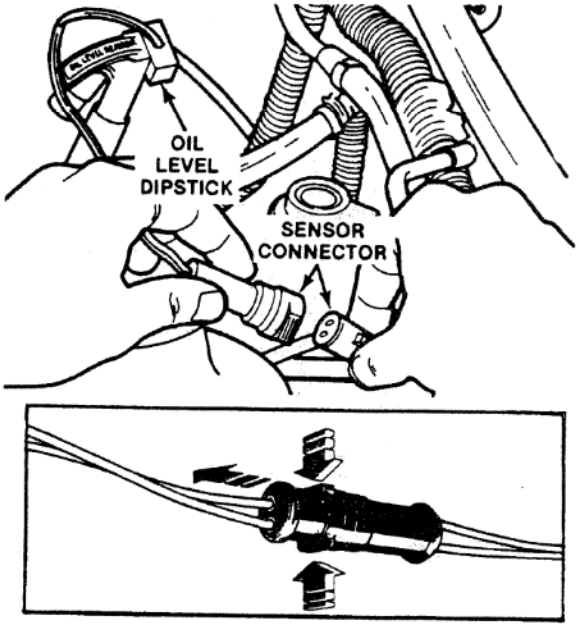


9. Remove the nut attaching the pulse damper to its bracket.



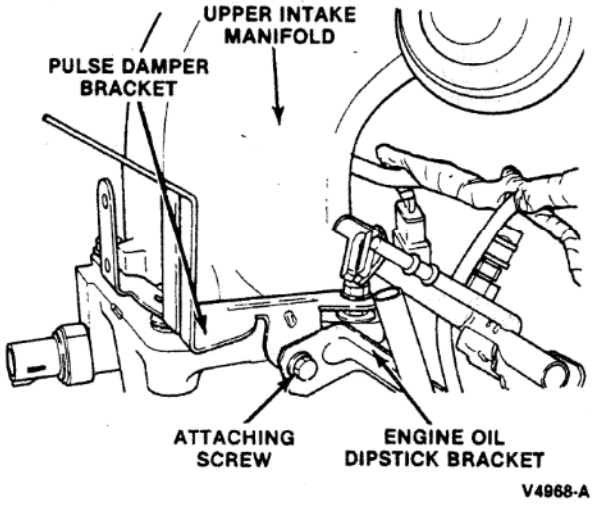
10. Disconnect the low oil level sensor connector and remove the engine oil level dipstick.

NOTE: Electrical connector at oil dipstick applies to all models built prior to 3-9-87.

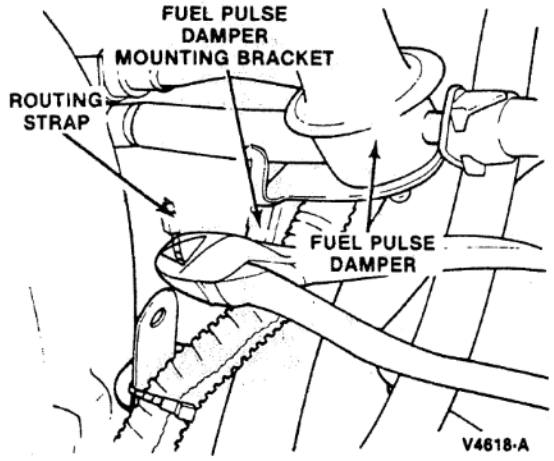


REMOVAL AND INSTALLATION (Continued)

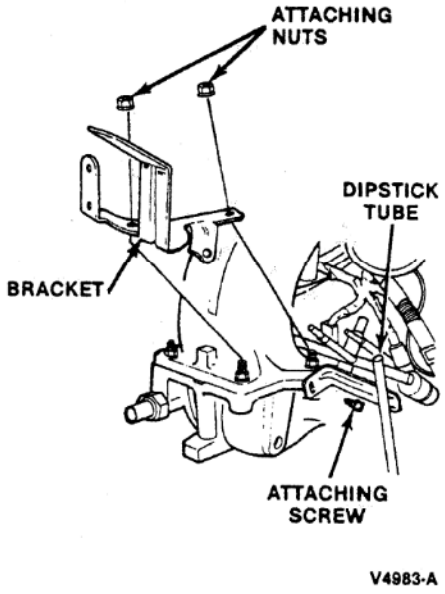
11. Remove the engine oil dipstick bracket attaching screw.



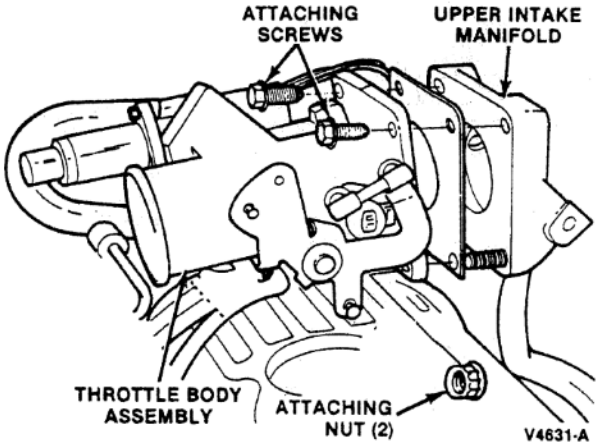
12. If necessary, cut the fuel injection wiring harness routing strap at the pulse damper bracket.



13. Remove the two pulse damper bracket attaching nuts and remove the bracket.

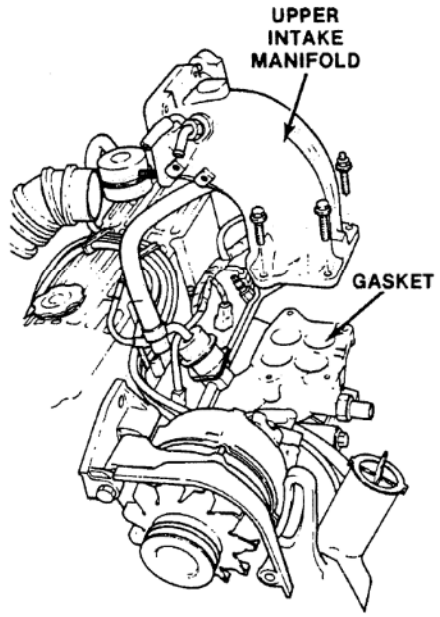


14. Remove two upper attaching screws and two lower attaching nuts connecting the throttle body assembly to the upper intake manifold.



REMOVAL AND INSTALLATION (Continued)

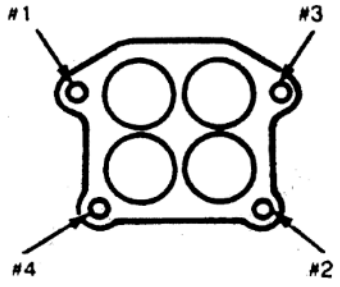
15. Remove the upper intake manifold attaching bolts, the manifold and gasket.



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Installation

1. Make sure both gasket surfaces on the upper intake manifold and the upper surface on the lower intake manifold are clean.



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2. Place a new service gasket on the lower intake manifold and place the upper intake manifold in position. Install the four attaching bolts and tighten to 20 to 30 N·m (15 to 22 lb-ft) in the sequence shown below.
3. Install the two EGR flange attaching bolts and tighten to 18 to 26 N·m (13 to 19 lb-ft).
4. Place the pulse damper bracket on the upper intake manifold and install the attaching nuts.
5. If necessary, install a new fuel injection wiring harness routing strap.
6. Install the engine oil dipstick bracket attaching screw.
7. Install the engine oil dipstick and connect the low oil level sensor connector.

   NOTE: Electrical connector at oil dipstick applies to 1986 and earlier models.

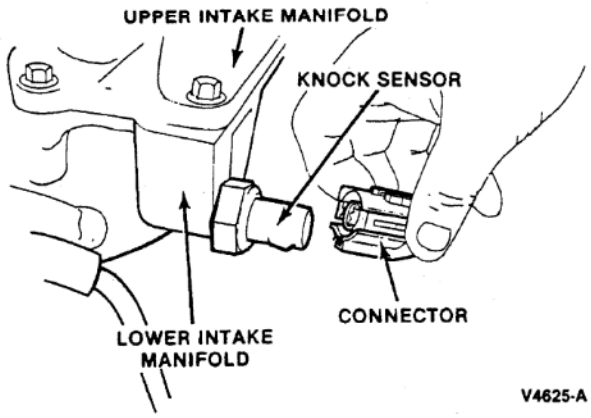
8. Place the pulse damper on its bracket and install the attaching nut.
9. Install a new gasket and the throttle body attaching screws and nuts. Tighten the screws and nuts to 16 to 20 N·m (12 to 15 lb-ft).
10. Connect the vacuum tree source hose to the intake manifold fitting.
11. Connect the PCV hose to the fitting on the upper intake manifold.
12. Connect the fuel pressure regulator vacuum hose to the fuel pressure regulator and to the fitting on the upper intake manifold.
13. Place the accelerator cable bracket against the upper intake manifold and install the attaching screws.
14. Connect the accelerator cable.
15. Connect the automatic transmission kickdown cable, if so equipped.
16. Install the turbocharger outlet hose and tighten the clamps.

REMOVAL AND INSTALLATION (Continued)

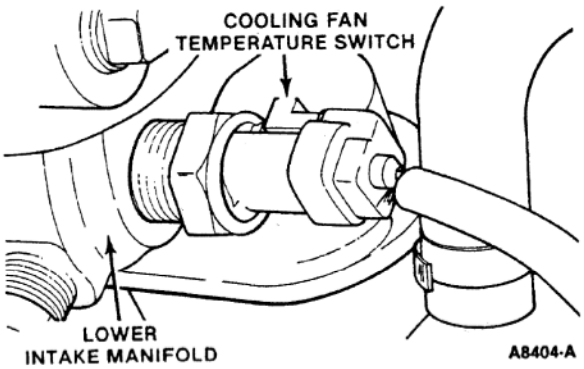
Lower Intake Manifold

Removal

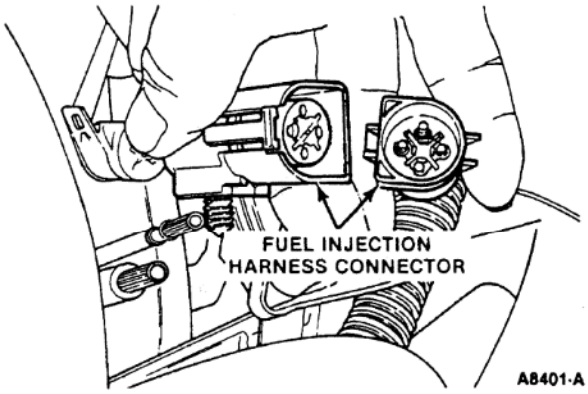
1. Drain the cooling system.
2. Disconnect the battery negative cable.
3. Disconnect the following electrical connectors:
   a. Knock sensor



   b. Fan temperature sensor



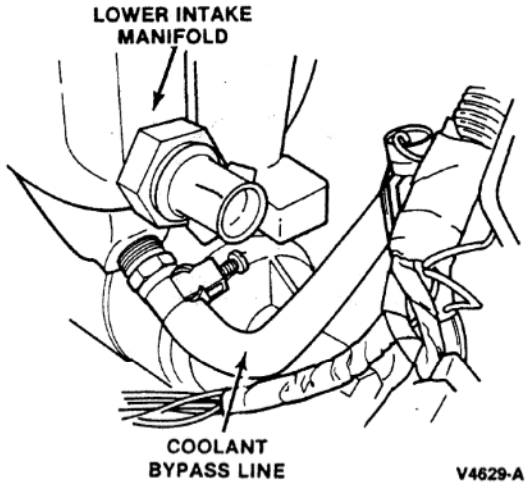
   c. Fuel injection wiring harness



   d. Coolant temperature sender (instrument cluster)

NOTE: The sender is located on the left side at the rear of the cylinder block below the oil pressure sender/turbocharger oil feed fitting.

4. Disconnect the coolant bypass line from the lower intake manifold.



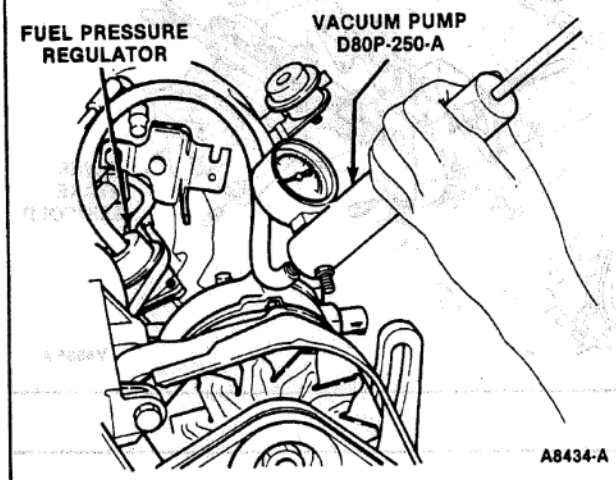
REMOVAL AND INSTALLATION

LOWER INTAKE MANIFOLD

Removal (Continued)

5. Depressurize the EFI fuel system using a hand-operated vacuum pump. Connect the pump hose to the fuel system pressure regulator. Apply at least 25" of vacuum.

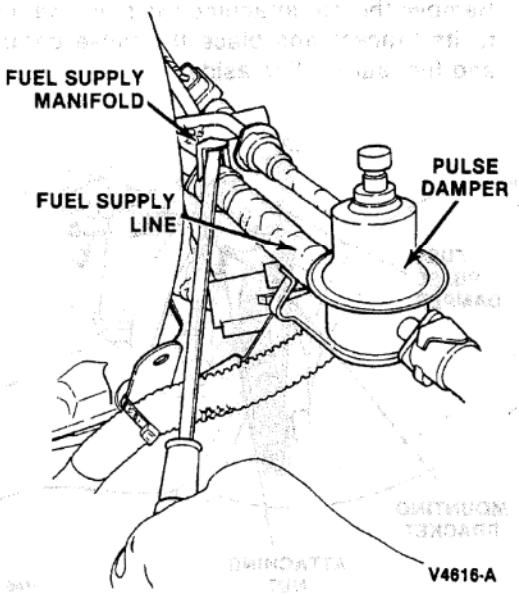
   If necessary, refer to the Fuel System Pressure Relief Procedure in Section 24-50.



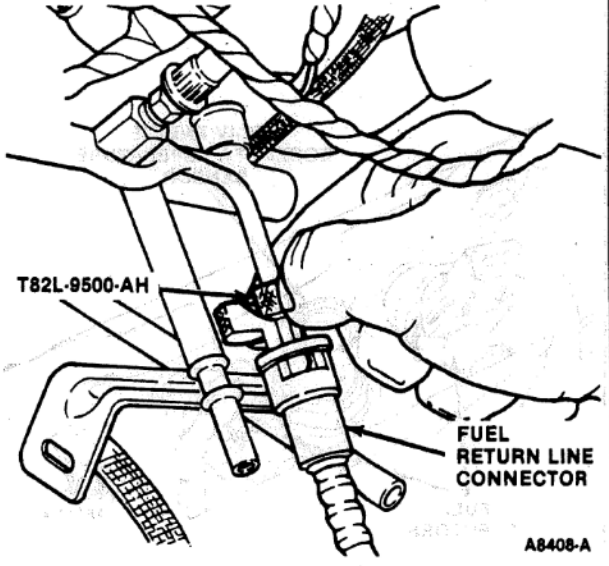
CAUTION: Fuel supply lines will remain pressurized for some period of time after the engine is shut off. System pressure must be relieved before disconnecting any fuel lines.

6. Disconnect the vacuum pump from the fuel pressure regulator.

7. Disconnect the fuel supply line from the fuel supply manifold.



8. Disconnect the fuel return line using tool T82L-9500-AH, or equivalent.

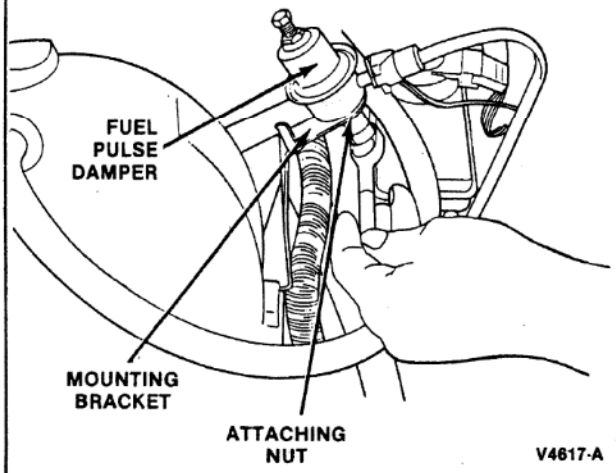


REMOVAL AND INSTALLATION

LOWER INTAKE MANIFOLD

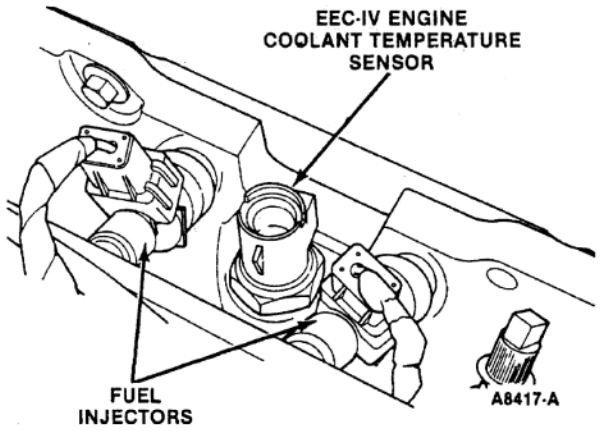
Removal (Continued)

9. Remove the nut attaching the pulse damper to its bracket and place the pulse damper and fuel supply line aside.

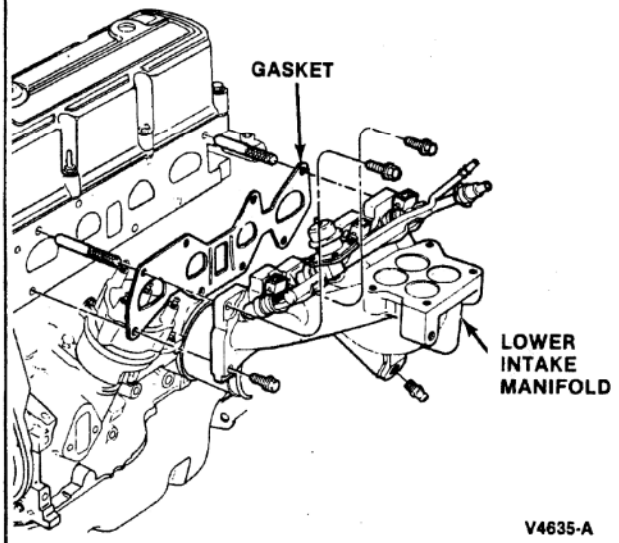


10. Remove the upper intake manifold. If necessary, refer to the procedure in this section.

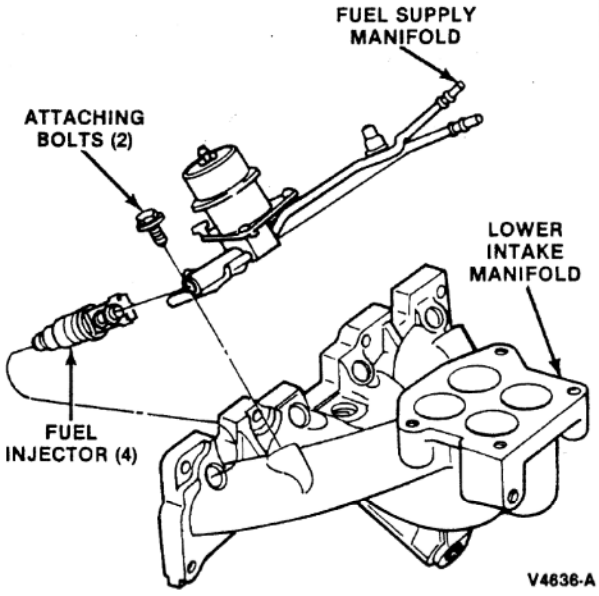
11. Disconnect the coolant temperature sensor (EEC).



12. Remove the upper (4) and lower (4) attaching bolts and the lower intake manifold and gasket.



13. Remove the two attaching bolts, disengage each injector and remove the fuel supply manifold assembly.

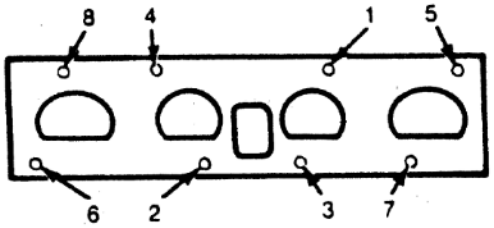


REMOVAL AND INSTALLATION

LOWER INTAKE MANIFOLD

Installation

1. Clean and inspect the mounting surfaces of the lower intake manifold and the cylinder head. Both surfaces must be clean and flat.
2. Install a new gasket.
3. Position the lower intake manifold on the cylinder head and install the four upper attaching bolts fingertight.
4. Install the four lower manifold bolts and tighten all bolts to 16 to 20 N·m (12 to 15 lb-ft), in the sequence shown below.



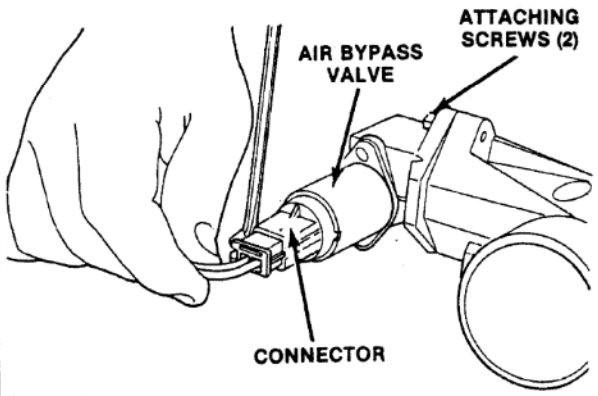
V4637-A

5. Install the fuel supply manifold assembly by pressing each injector into place on the lower intake manifold and installing the two attaching bolts.
6. Make sure the gasket surfaces of the upper and lower intake manifolds are clean.
7. Install the coolant temperature sensor (EEC).
8. Install the upper intake manifold and two gaskets. If necessary, refer to the procedure in this section.
9. Connect the fuel return line.
10. Place the pulse damper on its bracket and connect the fuel supply tube.
11. Connect the coolant bypass line to the lower intake manifold.
12. Connect the following electrical connectors:
    a. Knock sensor
    b. Fan temperature sensor
    c. Fuel injection wiring harness
    d. Coolant temperature sender (instrument cluster)
13. Connect the battery negative cable.
14. Fill the cooling system. If necessary, refer to the procedure in Section 27-03.

AIR BYPASS VALVE

Removal

1. Disconnect the air bypass valve electrical connector.



V4626-A

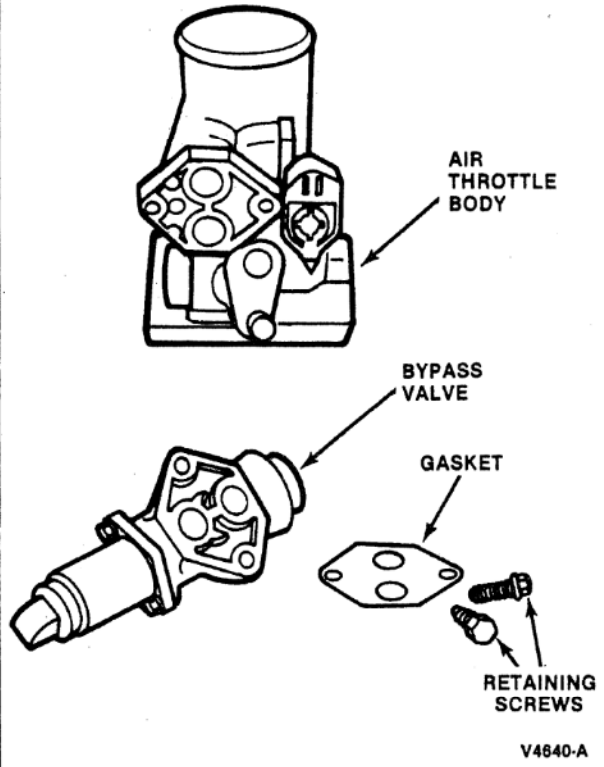
2. Remove the two air bypass valve attaching screws.

REMOVAL AND INSTALLATION

AIR BYPASS VALVE

Removal (Continued)

3. Remove the air bypass valve and gasket.



NOTE: If it is necessary to scrape gasket material off of the gasket surfaces, be careful not to damage the air bypass valve or throttle body gasket surface, or drop gasket material into the throttle body.

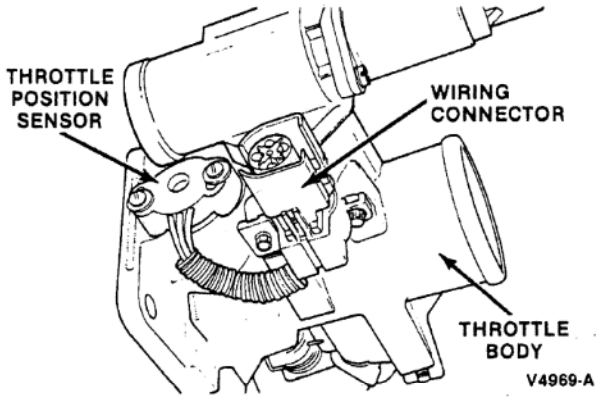
Installation

1. Make sure both throttle body and bypass valve gasket surfaces are clean.
2. Install a new gasket, the air bypass valve and the two attaching screws. Tighten the screws to 8 to 11 N·m (6 to 8 lb-in.).
3. Connect the air bypass valve electrical connectory.

THROTTLE POSITION SENSOR

Removal

1. Remove the throttle body assembly from the vehicle. If necessary, refer to the procedure in this section.
2. Scribe marks on the throttle body and on the throttle position sensor to indicate proper alignment during installation.
3. Remove the throttle position sensor attaching screws.
4. Remove the throttle position sensor pigtail connector attaching screws and remove the throttle position sensor assembly.
5. Remove the bushing from the throttle shaft bore.



Installation

1. Install the bushing in the throttle shaft bore.
2. Install the throttle position sensor and gasket. Make sure that the rotary tangs on the sensor are in proper alignment with the throttle shaft blade.

CAUTION: Slide the rotary tangs into position over the throttle shaft blade, then rotate the throttle position sensor to the installed position. Failure to install the throttle position sensor in this manner may result in excessive idle speeds.

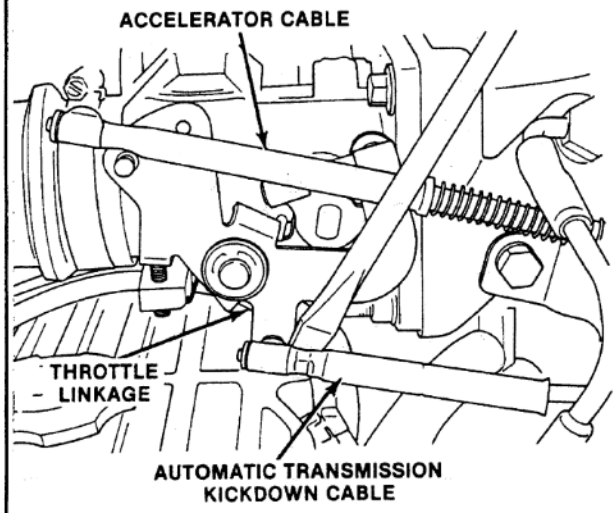
3. Align the scribe marks on the throttle body and the throttle position sensor and secure the sensor to the throttle body with the two attaching screws. Tighten the screws to 1.6 to 1.8 N·m (14 to 16 lb-in.).
4. Install the pigtail connector and attaching screws and tighten the screws to 1.6 to 1.8 N·m (14 to 16 lb-in.).

REMOVAL AND INSTALLATION

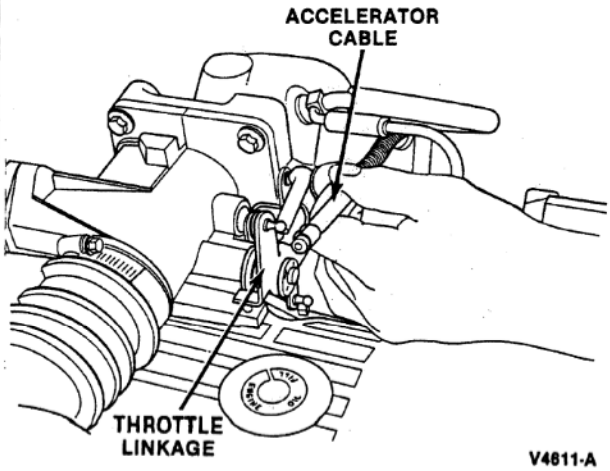
FUEL SUPPLY MANIFOLD

Removal

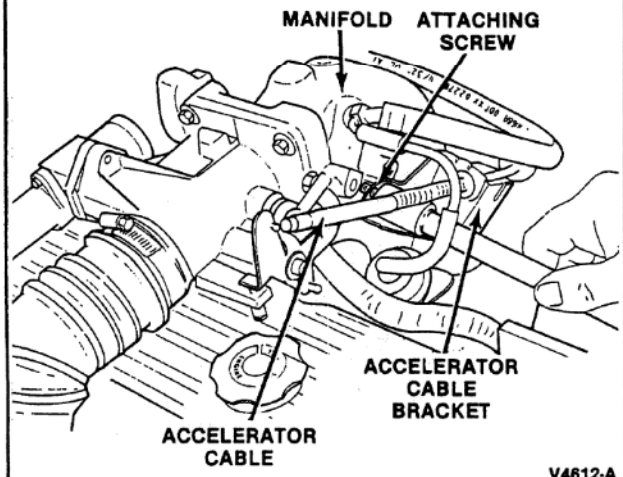
1. Disconnect the battery negative cable.
2. If the vehicle is equipped with an automatic transmission, disconnect the kickdown cable from the throttle linkage.



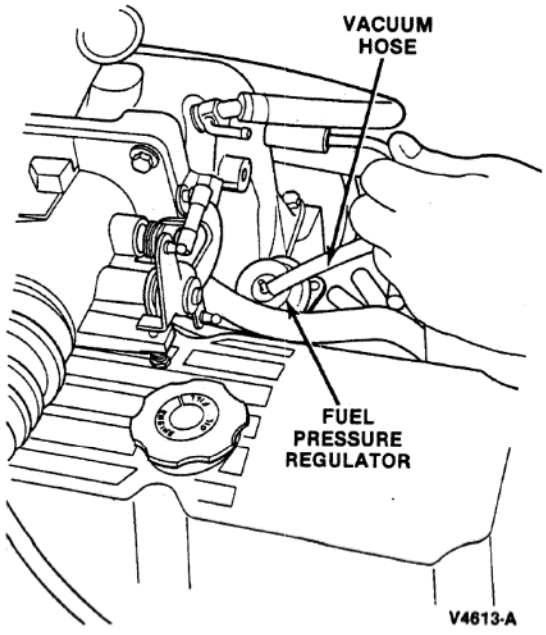
3. Disconnect the accelerator cable from the throttle linkage (manual transmission–equipped vehicle shown).



4. Remove the screws attaching the accelerator cable bracket to the upper intake manifold. Place the bracket, accelerator cable and automatic transmission kickdown cable (if so equipped) aside.



5. Disconnect the fuel pressure regulator vacuum hose from the fuel pressure regulator and the upper intake manifold fitting.

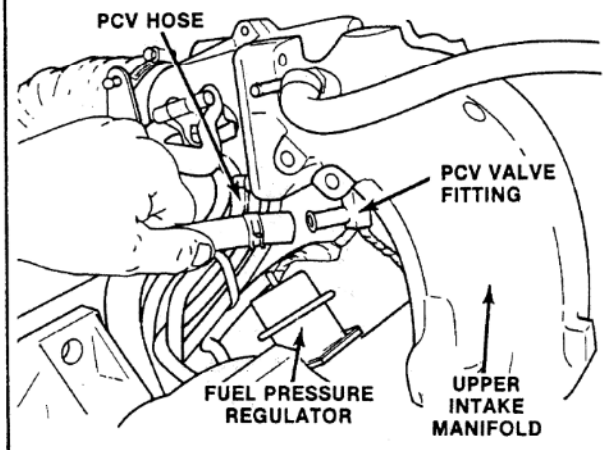


REMOVAL AND INSTALLATION

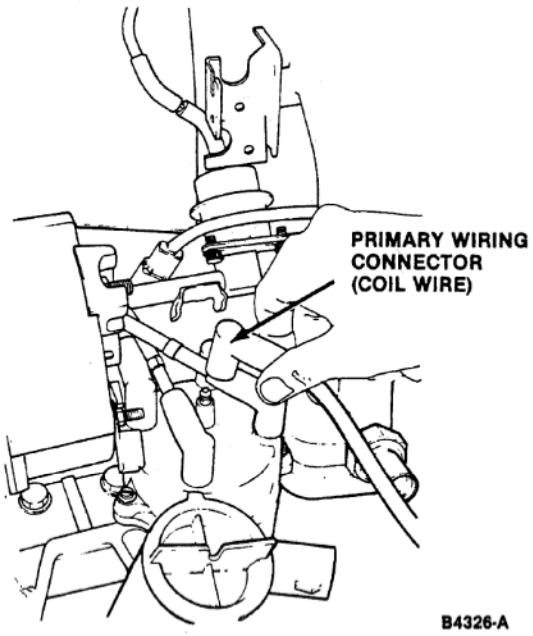
FUEL SUPPLY MANIFOLD

Removal (Continued)

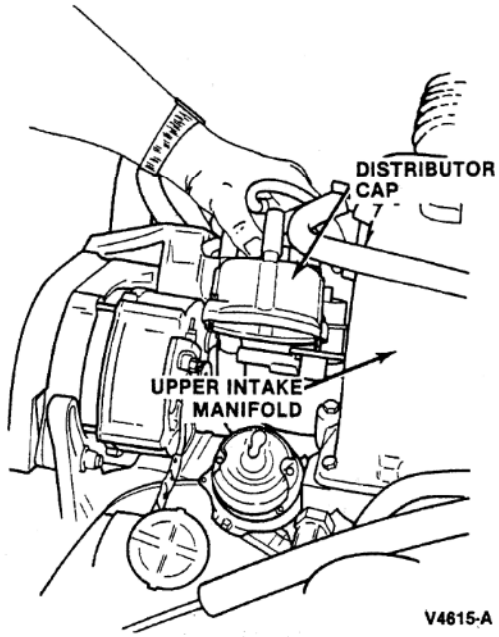
6. Disconnect the positive crankcase ventilation (PCV) hose at the upper intake manifold fitting.



7. Disconnect the coil wire from the distributor cap and place it aside.

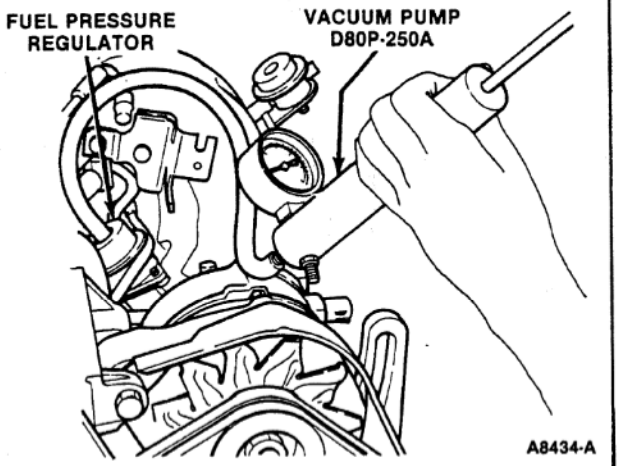


8. Remove the distributor cap attaching screws and cap. Place the distributor cap and attached wires aside.



9. Depressurize the EFI fuel system using a hand-operated vacuum pump. Connect the pump hose to the fuel system pressure regulator and apply at least 25″ of vacuum.

NOTE: It takes at least three minutes for the system to depressurize. If necessary, refer to the Fuel System Pressure Relief Procedure in Section 24-50.



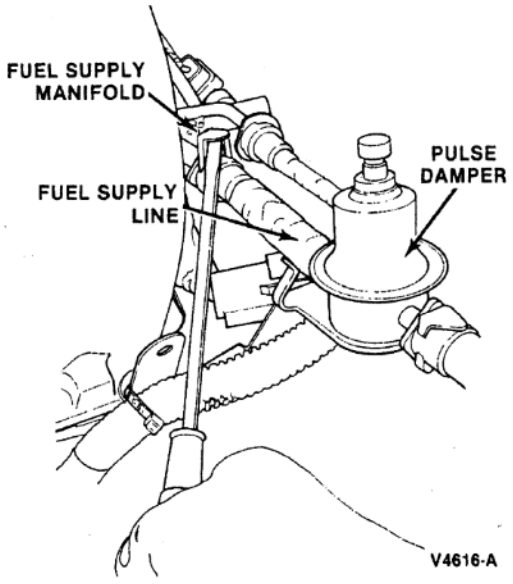
REMOVAL AND INSTALLATION

FUEL SUPPLY MANIFOLD

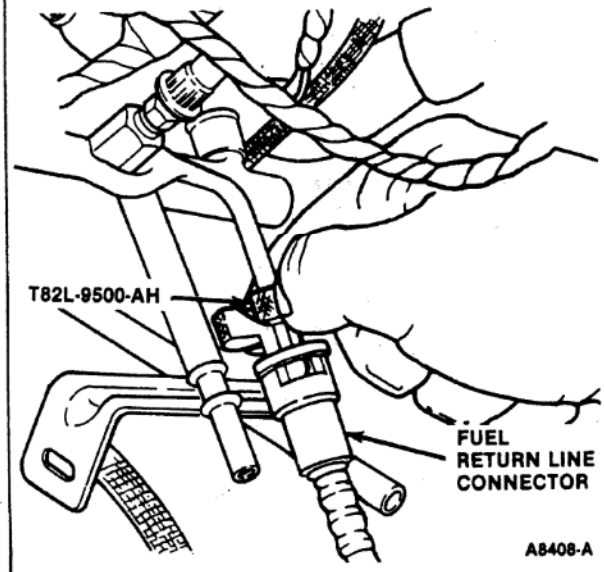
Removal (Continued)

CAUTION: Fuel supply lines will remain pressurized for some period of time after the engine is shut off. System pressure must be relieved before disconnecting any fuel lines.

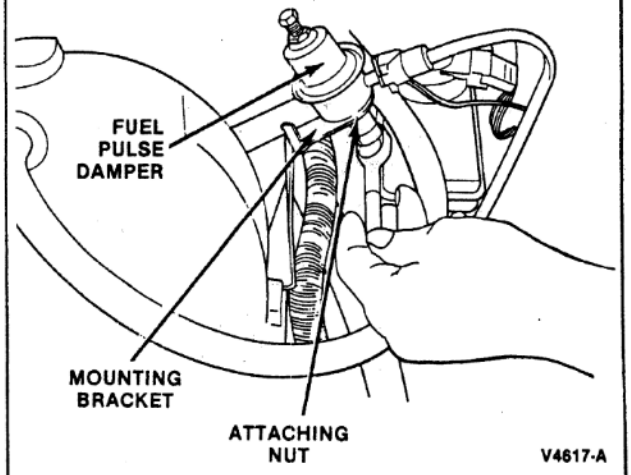
10. Disconnect the vacuum pump from the fuel pressure regulator.
11. Disconnect the fuel supply line from the fuel supply manifold.



12. Disconnect the fuel return line using tool T822-9500-AH, or equivalent.



13. Remove the nut attaching the fuel pulse damper to its mounting bracket.

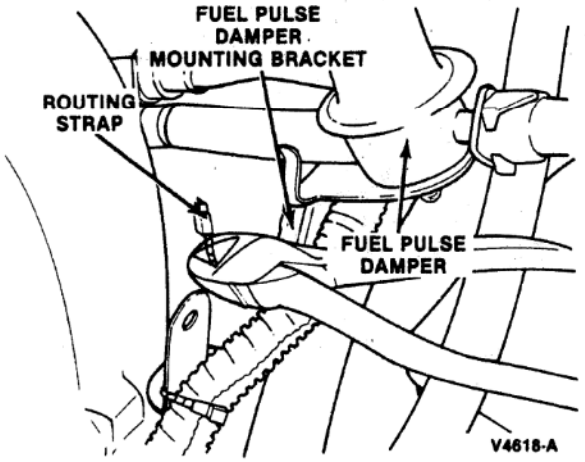


REMOVAL AND INSTALLATION

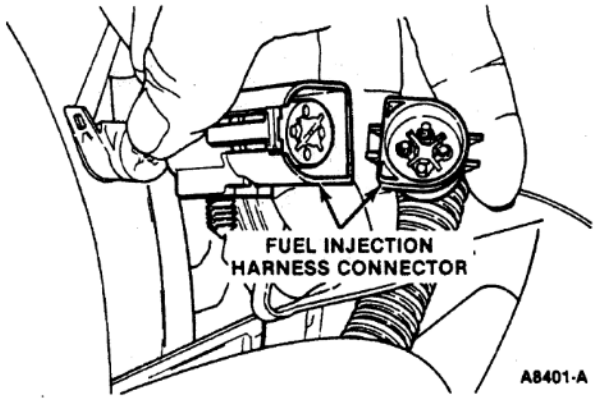
FUEL SUPPLY MANIFOLD

Removal (Continued)

14. If necessary, cut the fuel injection wiring harness routing strap at the fuel pulse damper bracket.

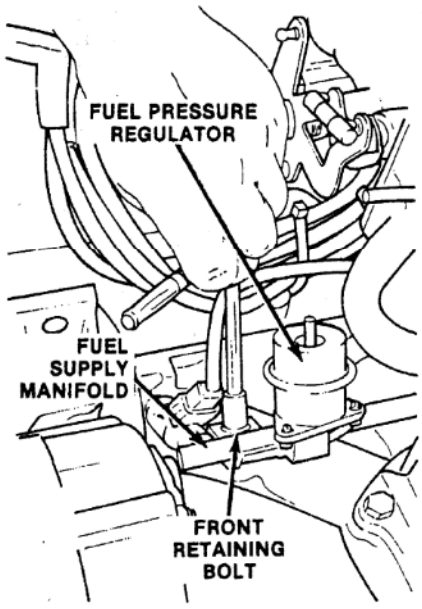


15. Disconnect the fuel injection wiring harness connector.

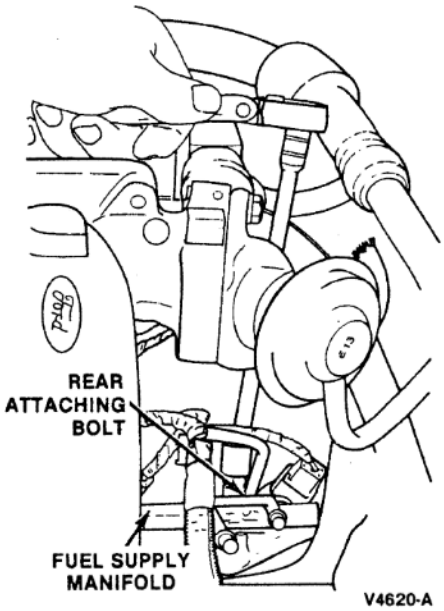


16. Disconnect the wiring connector from the coolant temperature sender at the cylinder block.

17. Remove the fuel supply manifold assembly front attaching bolt.



18. Remove the fuel supply manifold assembly rear attaching bolt.

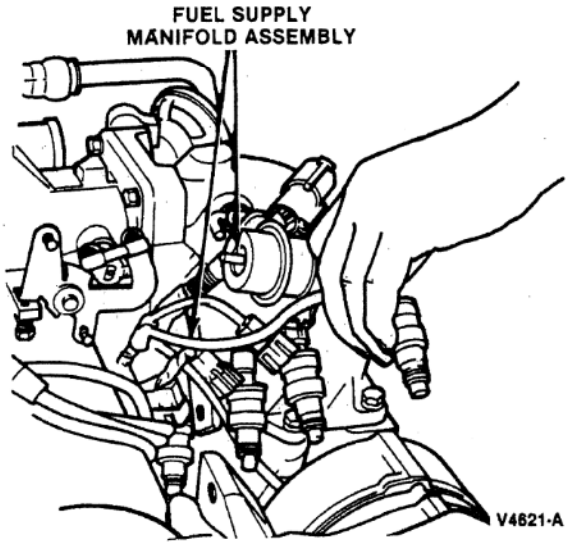


REMOVAL AND INSTALLATION

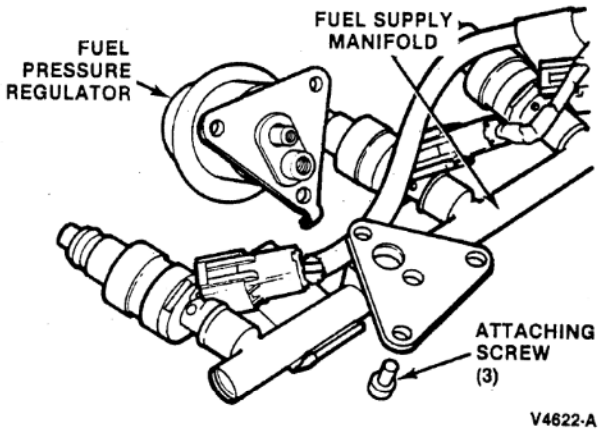
FUEL SUPPLY MANIFOLD

Removal (Continued)

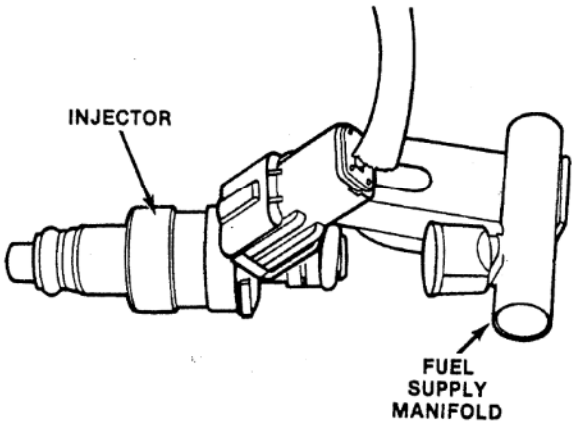
19. Remove the fuel supply manifold assembly by disengaging each fuel injector from the lower intake manifold, then carefully pulling the whole assembly out from under the upper intake manifold toward the front of the engine.



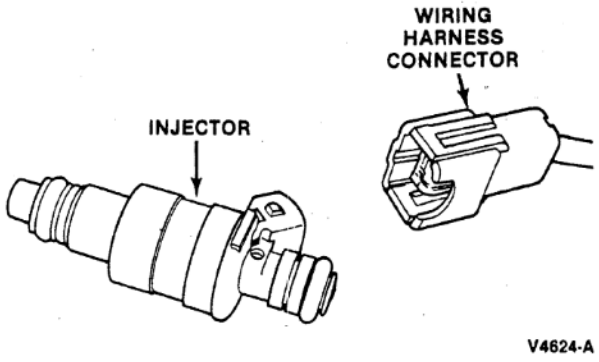
20. Remove the three allen-head attaching screws and the fuel pressure regulator from the fuel supply manifold.



21. Remove each injector from the fuel supply manifold.



22. Disconnect the wiring harness connector from each injector.



REMOVAL AND INSTALLATION

FUEL SUPPLY MANIFOLD

Removal (Continued)

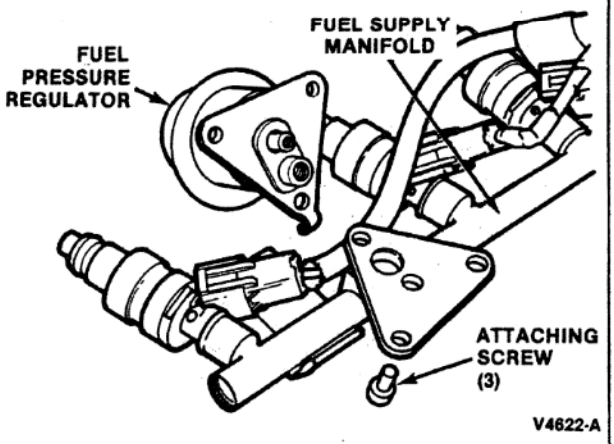
Installation

1. Install the injectors on the fuel supply manifold.
2. Install the fuel pressure regulator and three attaching screws.
3. Connect the wiring harness connector to each fuel injector.
4. Position the fuel supply manifold assembly under the upper intake manifold and insert each injector into its opening in the lower intake manifold.
5. Install the front and rear fuel supply manifold attaching bolts. Tighten the bolts to 20 to 30 N·m (15 to 22 lb-ft).
6. Connect the coolant temperature sender wiring connector.
7. Connect the fuel injection wiring harness connector.
8. If necessary, install a new fuel injection wiring harness routing strap on the fuel pulse damper bracket.
9. Place the fuel pulse damper in its mounting bracket and install the attaching nut.
10. Connect the fuel supply line and install the retaining clip.
11. Connect the fuel return line.
12. Install the distributor cap and attaching screws.
13. Connect the coil wire to the distributor cap.
14. Connect the PCV hose.
15. Connect the vacuum hose to the fuel pressure regulator and upper intake manifold fitting.
16. Position the accelerator cable bracket to the upper intake manifold and install the attaching screws.
17. Connect the accelerator cable to the throttle linkage.
18. If the vehicle is equipped with an automatic transmission, connect the kickdown cable to the throttle linkage.
19. Connect the battery negative cable.

FUEL PRESSURE REGULATOR

Removal

1. Remove the fuel supply manifold assembly from the vehicle. If necessary, refer to the procedure in this section.
2. Remove the attaching screws and the fuel pressure regulator from the fuel supply manifold.



Installation

1. Install the fuel pressure regulator and attaching screws on the fuel supply manifold.
2. Install the fuel supply manifold assembly. If necessary, refer to the procedure in this section.

FUEL INJECTOR

Removal

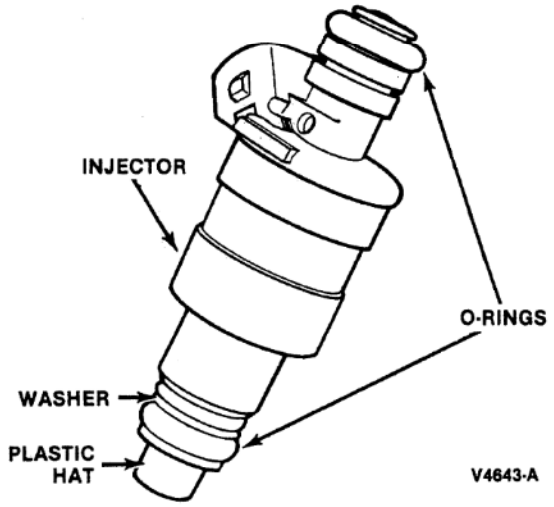
1. Perform steps 1 through 19 of the Fuel Supply Manifold Assembly Removal Procedure.
2. Carefully pull the fuel supply manifold away from all four injectors.
3. Disconnect the electrical connector from each injector that is to be removed.
4. Remove the desired injector(s) by grasping the injector body and pulling up while gently rocking the injector from side to side.

REMOVAL AND INSTALLATION

FUEL INJECTOR

Removal (Continued)

5. Inspect the injector O-rings for signs of deterioration. Replace as required.



6. Inspect the injector "plastic hat" (covering the injector pintle) and washer for signs of deterioration. Replace as required. If the hat is missing, look for it in the lower intake manifold.

Installation

1. Lubricate the O-rings with light grade oil ESF-M6C2-A, or equivalent, and install two on each injector.

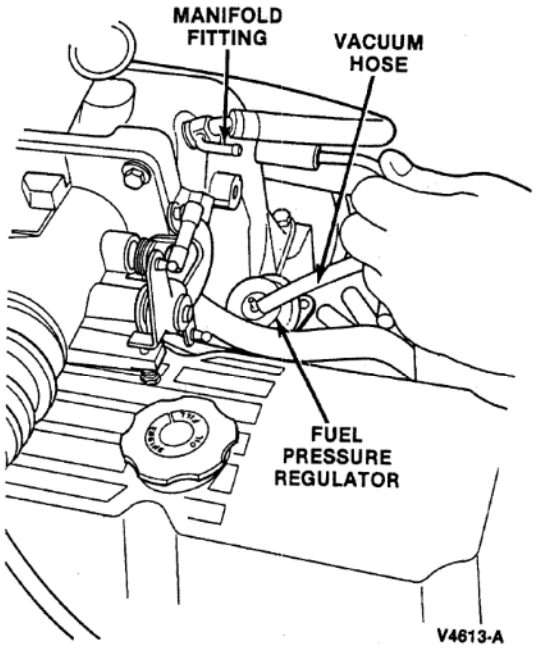
NOTE: Never use silicone grease. It will clog the injectors.

2. Install the injectors with a light, twisting, pushing motion.
3. Carefully seal the fuel supply manifold on the four injectors.
4. Connect the electrical connector to each injector.
5. Perform steps 5 through 20 of the Fuel Supply Manifold Installation Procedure.

FUEL INJECTION WIRING HARNESS

Removal

1. Disconnect the battery negative cable.
2. Disconnect the fuel pressure regulator vacuum hose from the fuel pressure regulator and the upper intake manifold fitting.



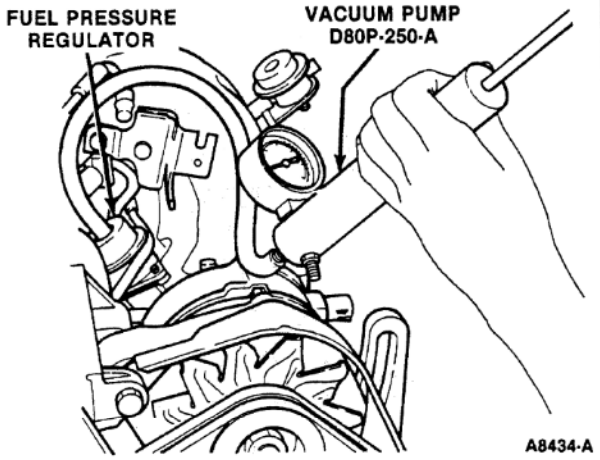
REMOVAL AND INSTALLATION

FUEL INJECTION WIRING HARNESS

Removal (Continued)

3. Depressurize the EFI fuel system using a hand-operated vacuum pump. Connect the pump hose to the fuel system pressure regulator and apply at least 25″ of vacuum.

NOTE: It takes at least three minutes for the system to depressurize. If necessary, refer to the Fuel System Pressure Relief Procedure in Section 24-50.

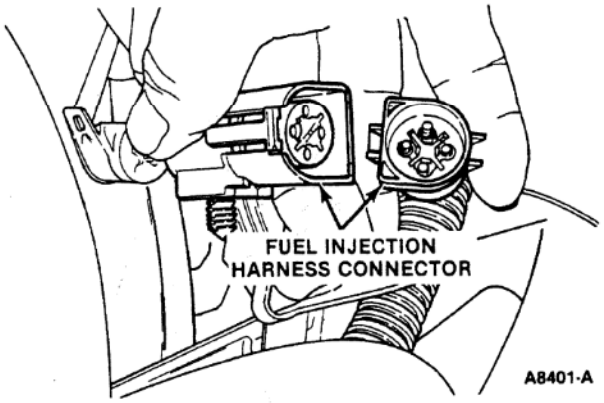


CAUTION: Fuel supply lines will remain pressurized for some period of time after the engine is shut off. System pressure must be relieved before disconnecting any fuel lines.

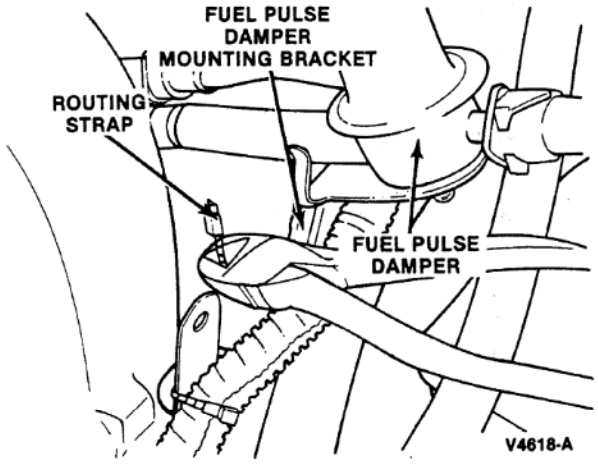
4. Disconnect the vacuum pump from the fuel pressure regulator.

5. Disconnect the electrical connectors from the four fuel injectors and from the coolant temperature sender on the engine block.

6. Disconnect the fuel injection wiring harness connector.



7. If necessary, cut the fuel injection wiring harness routing strap at the pulse damper bracket.

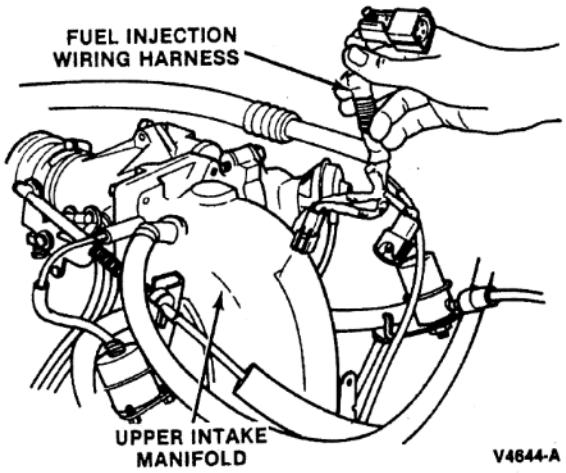


REMOVAL AND INSTALLATION

FUEL INJECTION WIRING HARNESS

Removal (Continued)

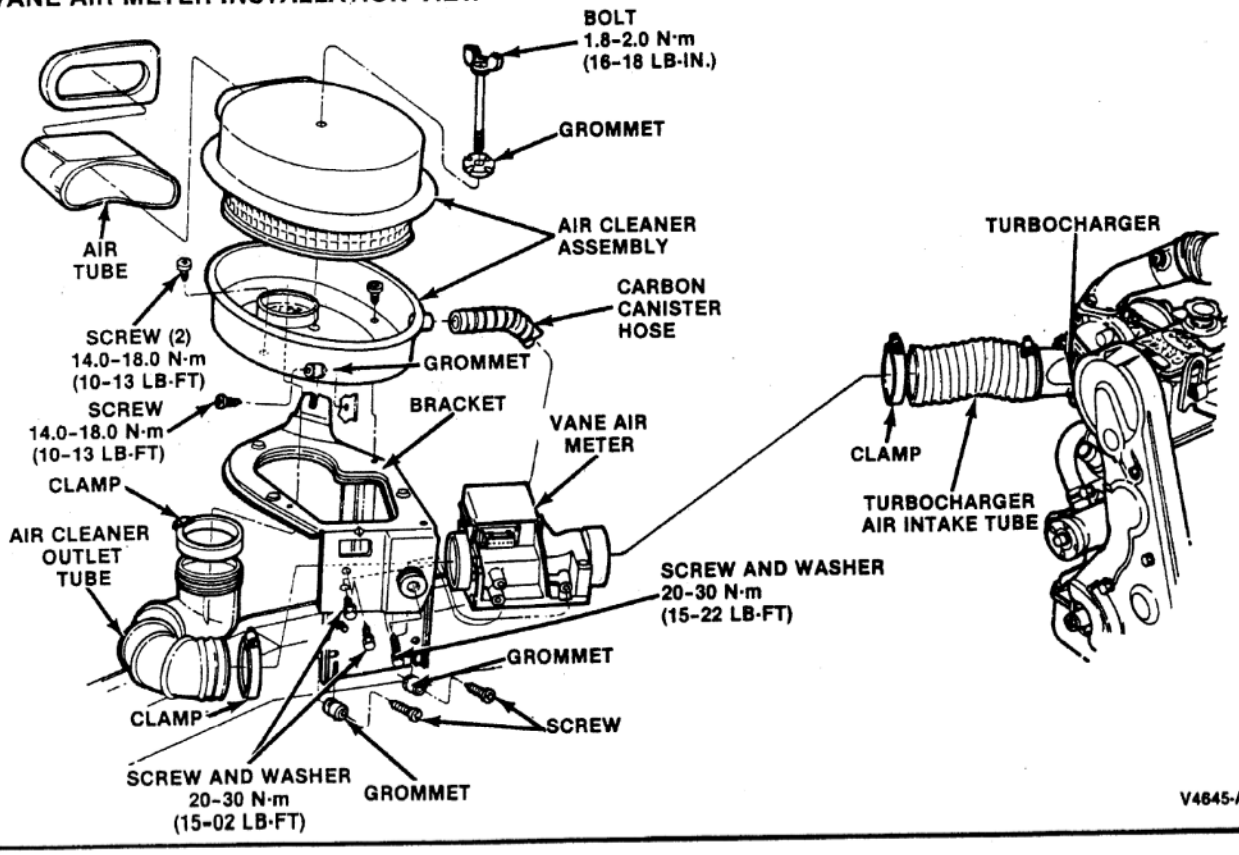
8. Remove the wiring harness.



Installation

1. Connect the fuel injection wiring harness connector.
2. Connect the engine temperature sender connector.
3. Connect the electrical connector to each injector.
4. If necessary, install a new routing strap at the pulse damper bracket.
5. Connect the fuel pressure regulator vacuum hose.
6. Connect the battery negative cable.

VANE AIR METER INSTALLATION VIEW

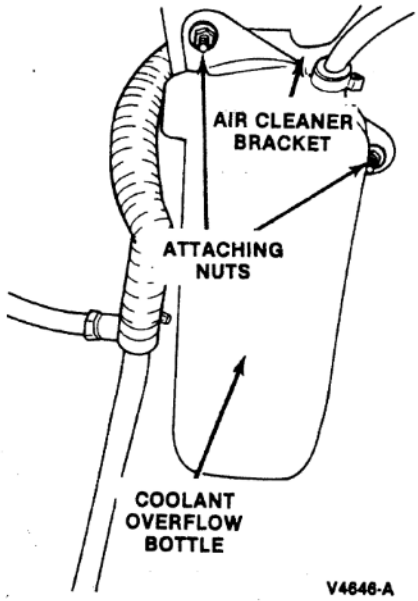


REMOVAL AND INSTALLATION

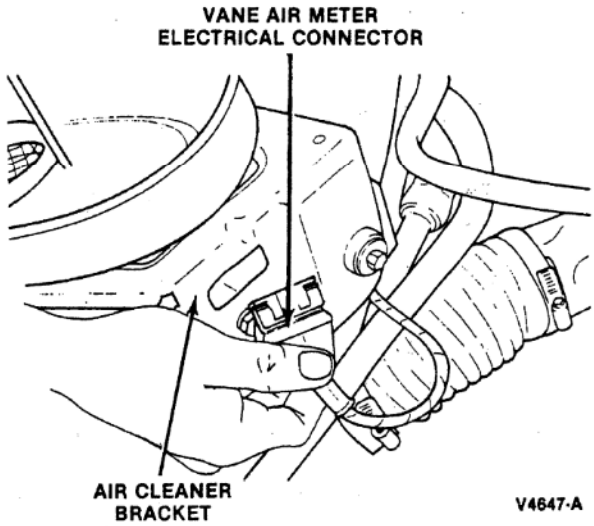
VANE AIR METER

Removal

1. Remove the air cleaner cover bolt and grommet and the air cleaner cover.
2. Remove the air cleaner element.
3. Disconnect the carbon canister hose.
4. Remove the two attaching nuts and the coolant overflow bottle from the air cleaner bracket. Support the bottle with a suitable length of wire attached to a convenient engine compartment component.



5. Loosen the clamp and disconnect the turbocharger air intake tube from the vane air meter.
6. Disconnect the vane air meter electrical connector.



7. Loosen the two lower air cleaner bracket attaching screws.
8. Remove the upper air cleaner bracket attaching screw and grommet.
9. Remove the lower half of the air cleaner housing, the air cleaner bracket, the air cleaner outlet tube and the vane air meter as an assembly.
10. Remove the three screws and grommet attaching the vane air meter to the air cleaner bracket.
11. Loosen the air cleaner outlet tube clamp at the vane air meter and remove the vane air meter.

REMOVAL AND INSTALLATION

VANE AIR METER

Installation

1. Clean mounting surfaces of vane air meter inlet and outlet flanges.
2. Install the air cleaner outlet tube on the vane air meter and tighten the clamp.
3. Install the three screws (and the grommet on the right hand screw) attaching the vane air meter to the air cleaner bracket. Tighten the screws to 20 to 30 N·m (15 to 22 lb-ft).
4. Install the bracket/vane air meter assembly in the vehicle by inserting the slots of the bottom of the bracket behind the lower attaching screw grommets.
5. Install the upper air cleaner bracket attaching screw and grommet. Tighten all three air cleaner bracket attaching screws to 20 to 30 N·m (15 to 22 lb-ft).
6. Connect the vane air meter electrical connector.
7. Connect the turbocharger air intake tube to the vane air meter and tighten the clamp.
8. Place the coolant overflow bottle in position against the air cleaner bracket and install and tighten the two attaching screws.
9. Connect the carbon canister hose.
10. Install the air cleaner element and cover.
11. Install the air cleaner cover bolt and grommet. Tighten the bolt to 1.8 to 2 N·m (16 to 18 lb-in.).

SECTION 24-35 ELECTRIC FUEL PUMPS

CONTENTS

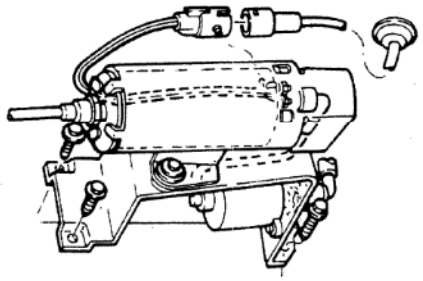
Page

DESCRIPTION

Low-Pressure Pump 1
High-Pressure Pump 2
Inertia Switch 2
Fuel Pump Circuit 3

REMOVAL AND INSTALLATION

Low-Pressure Pump 4
High-Pressure Pump 5
Inertia Switch 6
Fuel Pump Relay 7
In-Line Fuse 7

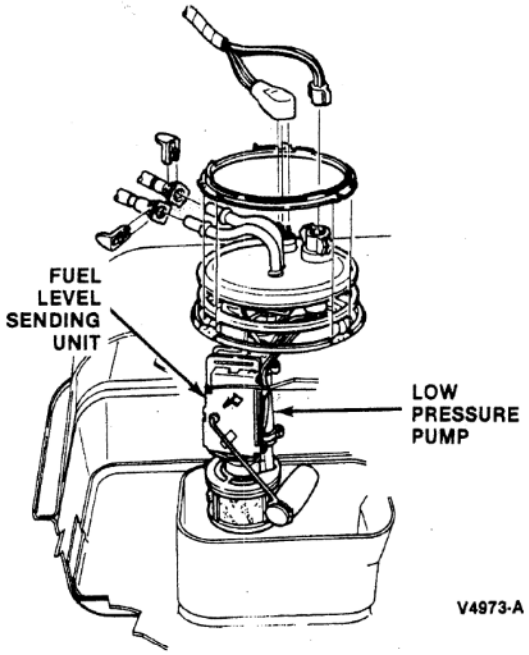


V4972-A

DESCRIPTION

LOW-PRESSURE PUMP

The low-pressure pump and fuel level sending unit are installed in the fuel tank as a single assembly. The pump draws fuel from the bottom of the tank and supplies it to the high-pressure pump. The two pumps are connected by 5/16" fuel line that extends from the tank fitting to the inlet side of the high-pressure pump. The end of the pump pickup is enclosed in a nylon filter which prevents the entry of fuel tank contaminants into the EFI system. The fuel pump is not serviced separately. The pump and sending unit are available only as an assembly.

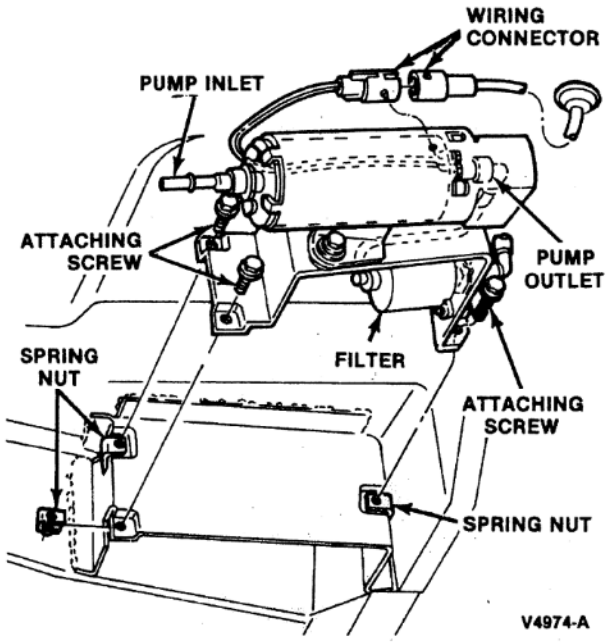


V4973-A

DESCRIPTION

HIGH-PRESSURE PUMP

The high-pressure pump is mounted on the left rear frame rail of the underbody. This pump delivers fuel under high pressure to the fuel manifold which routes the high-pressure fuel to the individual fuel injectors. The pump and manifold are connected by a 5/16" nylon fuel line. The pump has an internal relief valve to provide over-pressure protection in the event that fuel flow becomes restricted by a clogged fuel filter or pinched fuel line. The pressure relief valve is set at 950 kPA (138 psi). Normal system pressure is maintained at 270 kPa (39 psi) by the pressure regulator mounted on the fuel manifold. The pump is a sealed unit and is serviced only as an assembly.

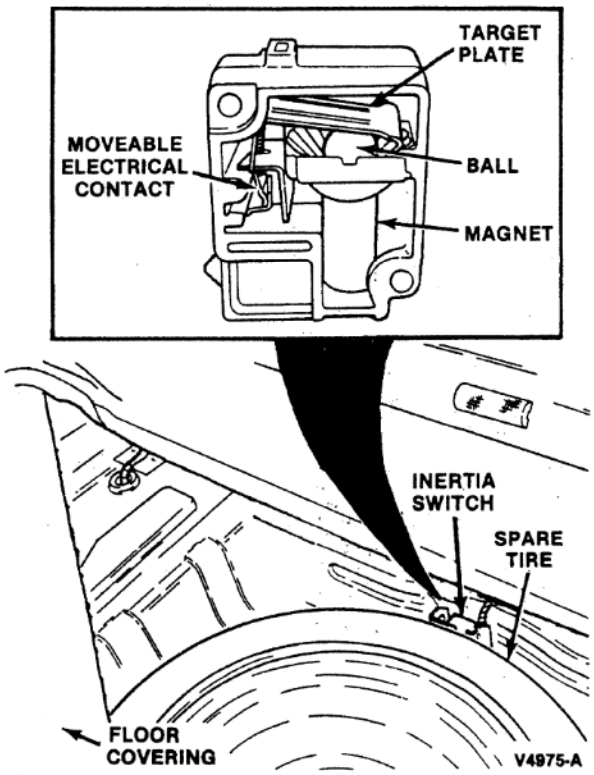


INERTIA SWITCH

The inertia switch is located at the center rear of the spare tire well. The inertia switch components are contained in a glass-filled polyester case. These components include a magnet, ball target plate, moveable electrical contact and a reset lever.

When impact forces exceed the magnetic force that retains the ball, the ball separates from the magnet and moves toward the target plate. When the ball hits the target plate, it triggers the moveable electrical contact that opens the electric circuit. When this circuit is opened, the high- and low-pressure pumps no longer receive battery current and stop pumping. With the fuel supply interrupted, the engine stops running and cannot be restarted until the inertia switch is manually reset. To reset the switch, open the liftgate, fold the floor covering back for access to the spare tire well and press the button on the top of the inertia switch.

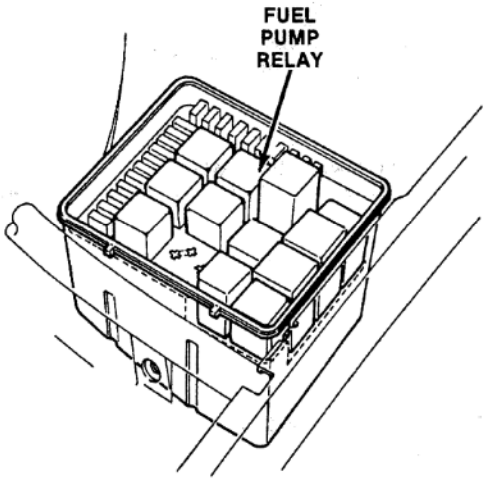
CAUTION: Do not reset the inertia switch until the complete fuel system has been inspected for leaks.

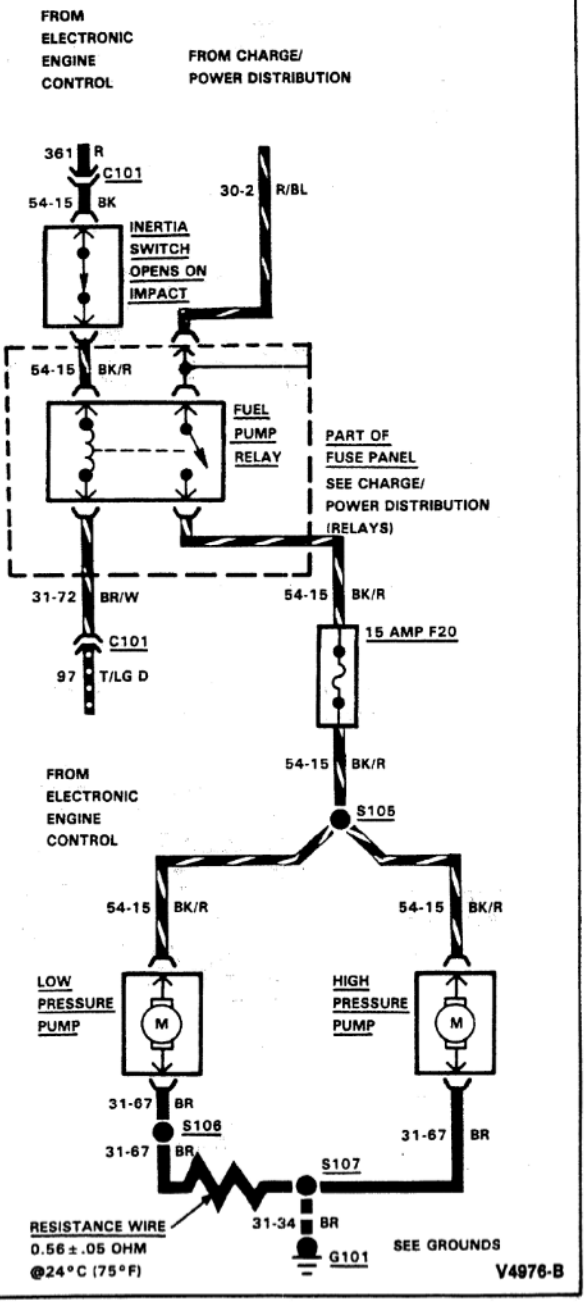


DESCRIPTION

FUEL PUMP CIRCUIT

When the ignition switch is turned to the ON position, the EEC relay closes and, as part of its function, supplies current to the fuel pump relay coil circuit. Closing of the fuel pump relay contact completes the circuit to the fuel pumps and a timing device in the EEC module. If the ignition switch is not turned to the crank position after one second, the timing device will open the fuel pump relay coil ground circuit, allowing the relay contacts to open. This circuit provides for pre-pressurization of the fuel system. The fuel pump circuit is protected by a 15 amp fuse in the circuit protection panel (Position 20).





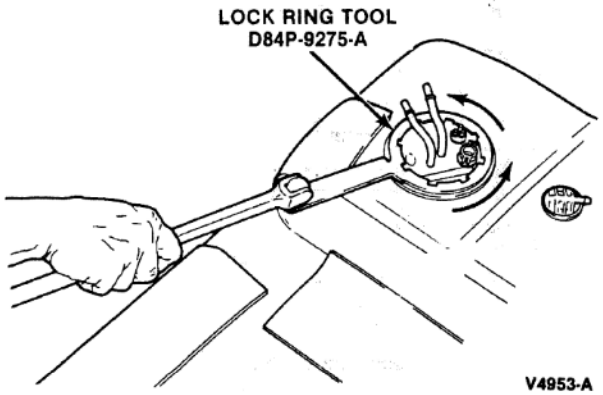
REMOVAL AND INSTALLATION

LOW-PRESSURE PUMP

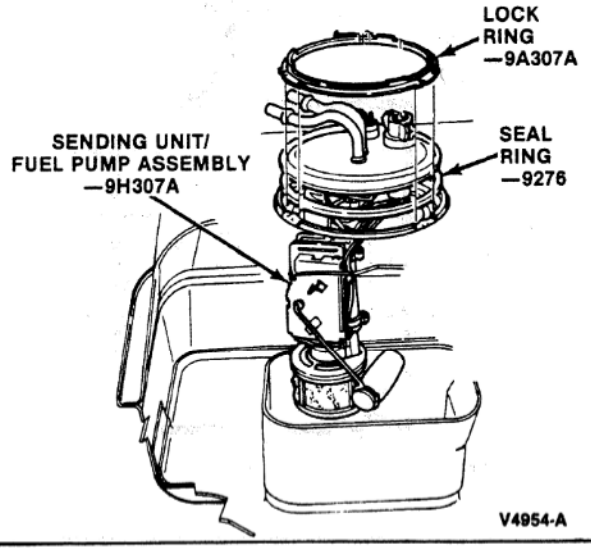
NOTE: The low-pressure pump is not serviced separately. It and the fuel sending unit are replaced as an assembly.

Removal

1. Remove the fuel tank. If necessary, refer to Section 24-50.
2. Remove the sending unit/fuel pump lock ring using Lock Ring Tool D84P-9275-A, or equivalent. Turn the lock ring counterclockwise to release from the tank.



3. Remove the lock ring, seal ring and sending unit/fuel pump from the fuel tank.



Installation

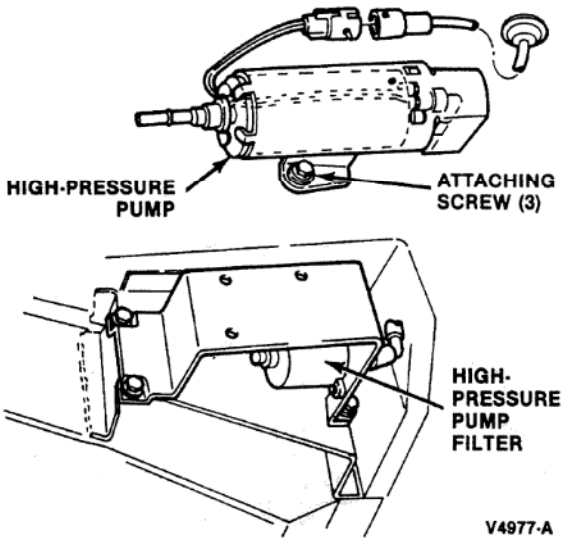
1. Clean the fuel tank seal ring groove.
2. Put a light coating of C1AZ-19590-B, or equivalent heavy-duty grease, on a new seal ring to prevent the lock ring from dragging on the seal during installation.
3. Position the new seal ring in the fuel tank groove.



4. Position the sending unit/fuel pump in the fuel tank.
5. Hold the assembly in position and install the lock ring fingertight. Make sure that all locking tabs are under the tank lock ring tabs.
6. Tighten the lock ring using Lock Ring Tool D84P-9275-A, or equivalent.
7. Install the fuel tank. If necessary, refer to Section 24-50.

REMOVAL AND INSTALLATION

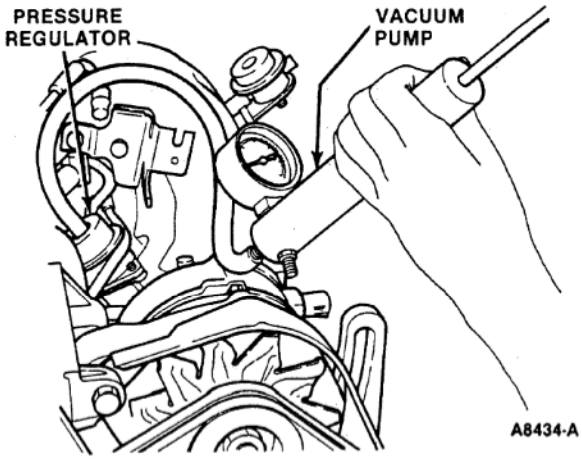
HIGH-PRESSURE PUMP



Removal

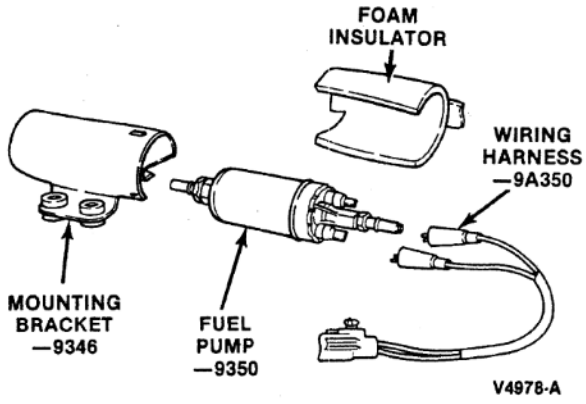
1. Depressurize the EFI fuel system using a hand-operated vacuum pump. Connect the pump hose to the fuel system pressure regulator and apply at least 25″ of vacuum.

NOTE: It takes at least three minutes for the system to depressurize. If necessary, refer to the Fuel System Pressure Relief Procedure in Section 24-50.



CAUTION: Fuel supply lines will remain pressurized for some period of time after the engine is shut off. System pressure must be relieved before disconnecting any fuel lines.

2. Raise the vehicle.
3. Separate the fuel pump electrical connector.
4. Disconnect the fuel lines at the pump inlet and outlet fittings.
5. Remove the pump bracket attaching screws and the pump.
6. Remove the pump and foam insulator from the mounting bracket.



7. Disconnect the wiring harness from the pump.

Installation

1. Connect the wiring harness to the pump.

   Make sure the wiring connector boots are pushed far enough onto the pump terminals to seal and that the wiring connectors are pushed onto the pump terminals fully.

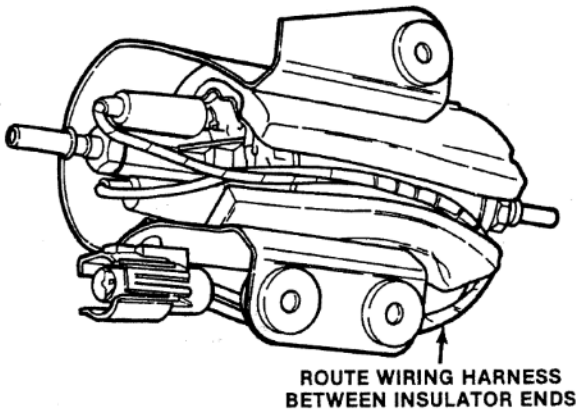
REMOVAL AND INSTALLATION

HIGH-PRESSURE PUMP

Installation (Continued)

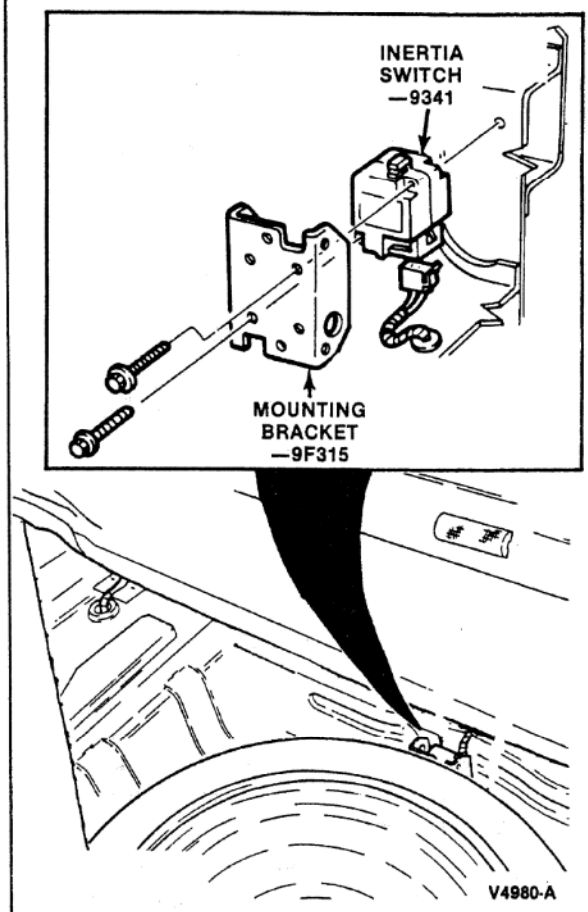
2. Wrap the insulator around the pump and install the pump in the mounting bracket.

   Make sure the insulator ends are positioned in the opening at the base of the mounting bracket.



3. Route the wiring harness through the bracket as shown in the illustration above.
4. Position the pump on the body mounting bracket and install the attaching screws.
5. Connect the pump wiring harness to the body wiring harness.
6. Connect the fuel lines.

INERTIA SWITCH



Removal

1. Open the liftgate, raise the rear parcel tray, and fold the floor covering back for access to the spare tire well.
2. Remove the mounting bracket attaching screws.
3. Disconnect the wiring harness and remove the switch.

Installation

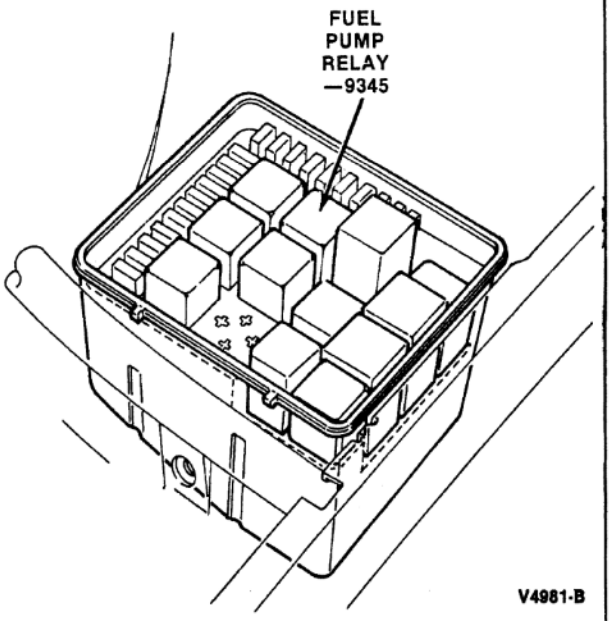
1. Connect the wiring harness to the switch.
2. Position the switch and mounting bracket and install the attaching screws.

REMOVAL AND INSTALLATION

FUEL PUMP RELAY

The fuel pump relay is located in the circuit protection panel.

The panel is located in the left rear corner of the engine compartment in the cowl well. To remove the relay, carefully grip with needle nose pliers and pull straight out.



SECTION 24-41 AIR CLEANER AND DUCT SYSTEM

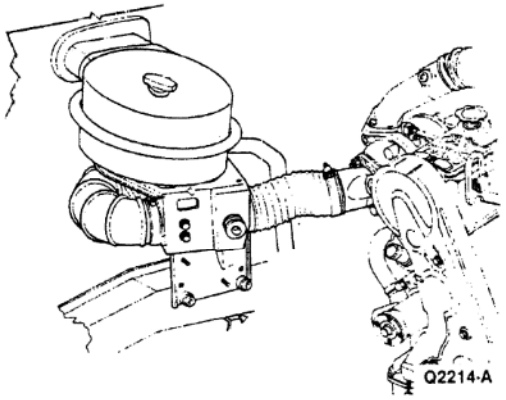
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DESCRIPTION 1

REMOVAL AND INSTALLATION

Air Filter Element 2



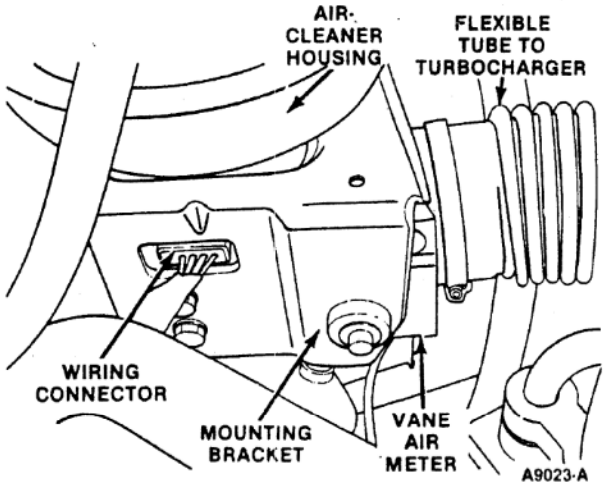
DESCRIPTION

The air filter element is enclosed in a two piece housing, located in the right front of the engine compartment. The lower housing is attached to the air cleaner mounting bracket with two sheet metal screws. A flexible tube connects the lower housing to the carbon canister. When the engine is running, gasoline vapors, stored in the canister, will be drawn into the engine through the housing and filter. The upper housing is secured to the lower housing with a wing nut, attached to the attaching screw. Air leakage between the housings is prevented by a foam gasket poured into the upper housing sealing flange.

Air enters the upper housing through a duct that extends through the right-inner fender panel to provide an air source from outside the engine compartment. Air is then drawn through the paper filter element into the lower housing.

From here the air flows through a molded rubber tube to the vane air meter, which measures the amount and temperature of the air entering the engine.

The filter element removes contaminants from the air before it enters the engine. Since the filter element is collecting and containing contaminants from the incoming air, the filter element has a limited service life. When the filter collects enough dirt and dust, it can become a restriction to the air flow. The length of time before the element begins to clog depends on the length of time the filter has been in service and the amount of contaminants in the air. Since the filter has a limited service life, inspect the element at regular intervals and replace if necessary.



REMOVAL AND INSTALLATION

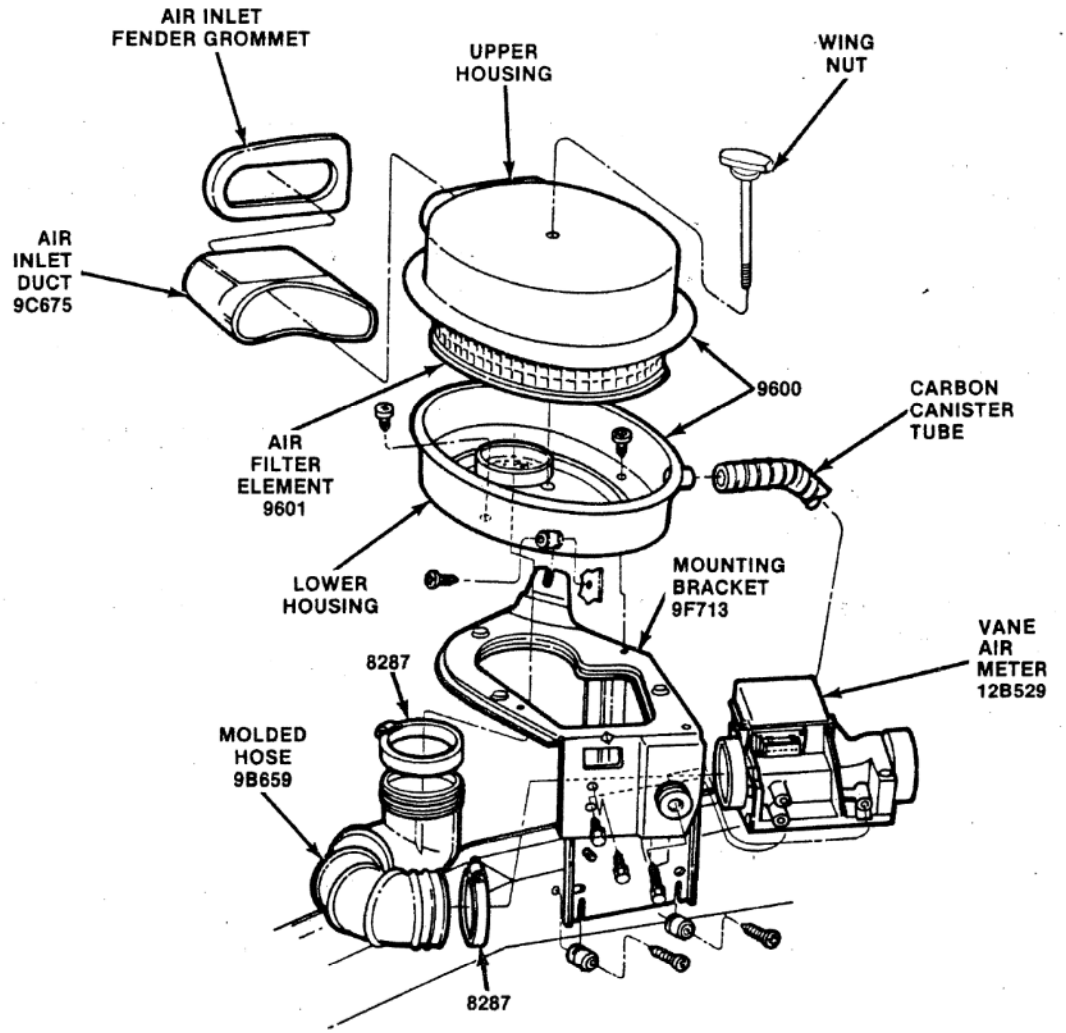
AIR FILTER ELEMENT

Removal

1. Remove the wing nut.
2. Remove the upper housing and filter element.
3. Visually inspect the air cleaner element and the air cleaner housings for signs of dirt, or dust leakage past the element end seals. Place a light on the inside of the filter and look through the filter at the light. Any hole in the element, even the smallest, is cause for replacement.

Installation

1. Wipe the inside surface of the housings and install the filter element in the clips in the upper housing.
2. Install the upper housing and filter element in the lower housing as an assembly. Make sure the element is fully seated around the flange in the lower housing.
3. Install the wing nut.



SECTION 24-45 TURBOCHARGER

CONTENTS

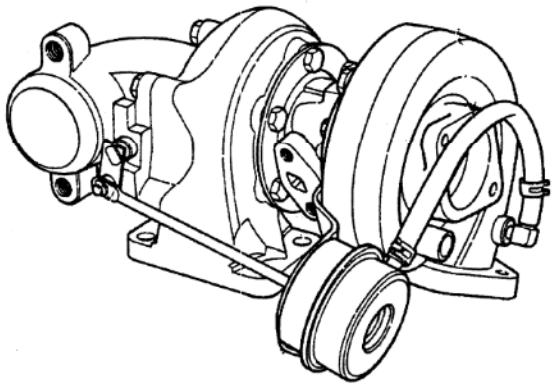
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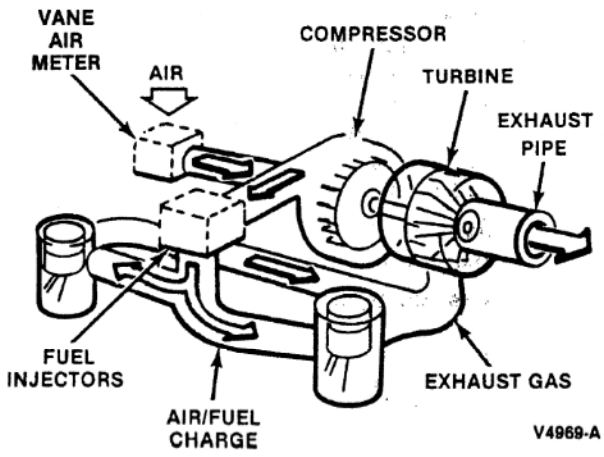
V4006-A

DESCRIPTION

TURBOCHARGER FUNCTION

The turbocharger is basically an air compressor that is connected into the air induction system to increase air flow into the engine. The 2.3L engine turbocharger is a blow-thru system which means the fuel metering devices—fuel injectors—are mounted downstream from the turbocharger rather than upstream as they would be in a draw-thru system. The energy required to compress the air is taken from the engine exhaust gases. By using heat and pressure normally expelled through the exhaust system, the turbocharged engine can increase heavy throttle and wide-open throttle power levels while maintaining, at part load, fuel economies of the smaller displacement engine. The turbine converts this normally wasted energy into rotating mechanical force. The rotational force of the turbine is transferred to the compressor side of the turbocharger through the interconnecting shaft.

At operating speed the spinning compressor wheel creates its own suction or vacuum at the air inlet elbow. This vacuum draws more air into the engine than the normal vacuum created by piston movement. The additional air is "pumped" into the intake manifold where it is mixed with fuel supplied by electronically controlled fuel injectors. As the turbocharger pressure forces the air/fuel mixture into the cylinders, it becomes tightly packed. This denser and heavier mixture burns with greater force that increases horsepower and torque in comparison with non-turbocharged engines of the same displacement. This is the power increase referred to as "boost."



V4969-A

Use the illustration above and the following as a summary of turbocharger operation.

DESCRIPTION

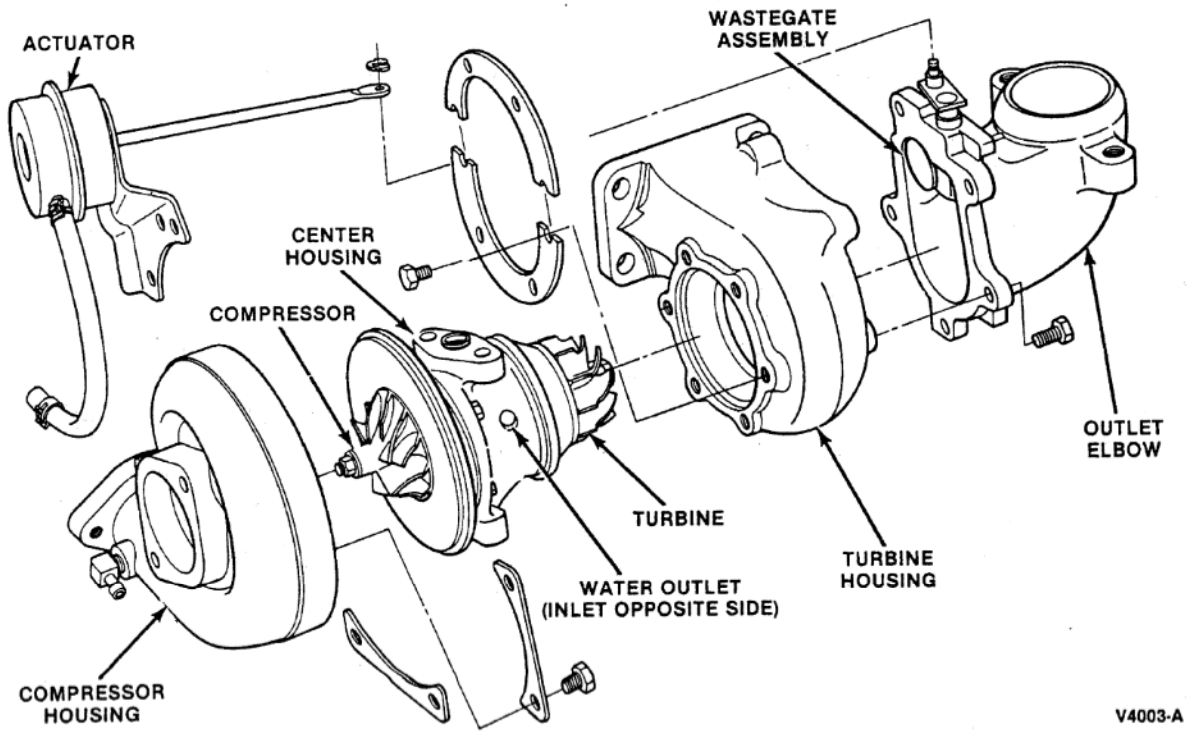
TURBOCHARGER FUNCTION

1. Exhaust gas pressure and heat energy cause the turbine wheel to rotate, which causes the compressor wheel to rotate.
2. A vane air meter, located below the air cleaner assembly, measures intake air flow and temperature.
3. The rotating compressor wheel compresses the air it receives and delivers it under pressure to the intake manifold.
4. Fuel is introduced "downstream" of the compressor and mixes with the air charge.
5. The denser air-fuel charge in the combustion chamber develops more horsepower during the combustion cycle.
6. Exhaust gas from the exhaust manifold flows into the turbine.
7. The cooled, expanded exhaust gas is directed by the turbine housing to the exhaust system.

TURBOCHARGER CONSTRUCTION

The turbocharger consists of only five major components:

- The wastegate ACTUATOR, which is a spring-loaded diaphragm device, senses and controls the pressure from the compressor outlet.
- The COMPRESSOR is a centrifugal, radial outflow type.
- The TURBINE is a centripetal, radial inflow type, which drives the compressor.
- The outlet elbow contains the WASTEGATE ASSEMBLY, which allows a portion of the exhaust gas to bypass the turbine wheel, limiting compressor speed.
- The water-cooled CENTER HOUSING supports the bearings, the compressor, turbine wheels and oil seals.

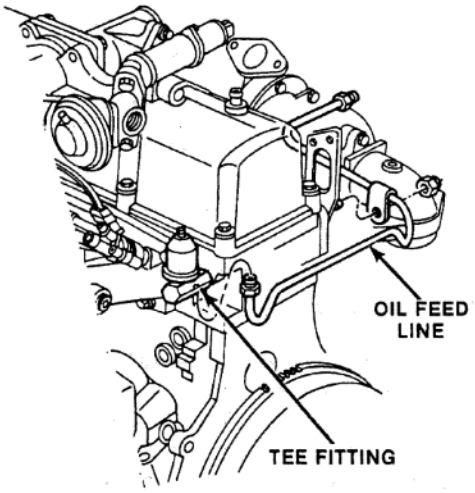


DESCRIPTION

LUBRICATION AND COOLING

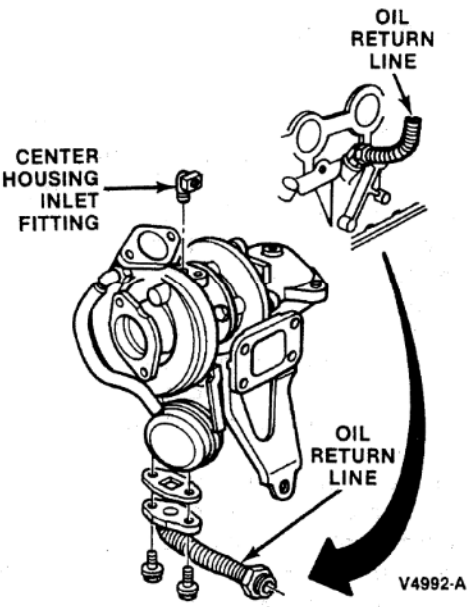
The rotating assembly is supported on two pressure-lubricated bearings and because a turbocharger can operate at speeds up to 120,000 revolutions per minute, lubrication of the bearings which support the shaft is important for cooling and friction reduction.

The turbocharger bearings are lubricated with engine oil supplied through a tube routed from the turbocharger center housing to a supply fitting threaded into the oil pressure sending unit port.

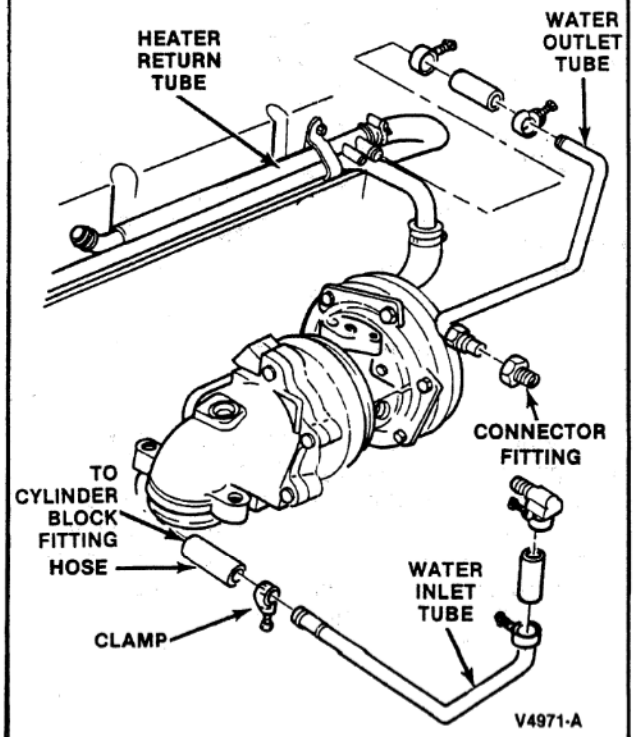


A piston ring seal is used on the turbine wheel shaft end to prevent engine oil leakage into the turbine wheel housing. A carbon face seal is used on the compressor wheel shaft end to prevent engine oil leakage into the compressor wheel housing.

The engine oil drains from the turbocharger through a return hole in the center housing and returns to the engine through an oil return tube connected between the bottom of the turbocharger and the side of the engine block.



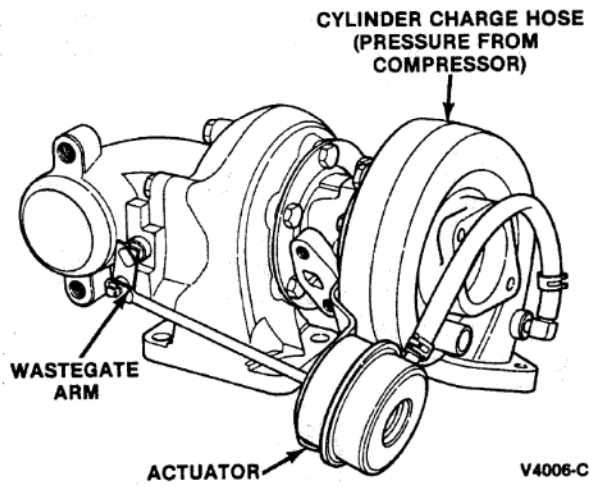
The turbocharger is also cooled by engine coolant circulating through the center housing. Coolant is routed to the turbocharger from the cylinder block, circulates through the center housing and returns to the radiator through the heater return tube.



DESCRIPTION

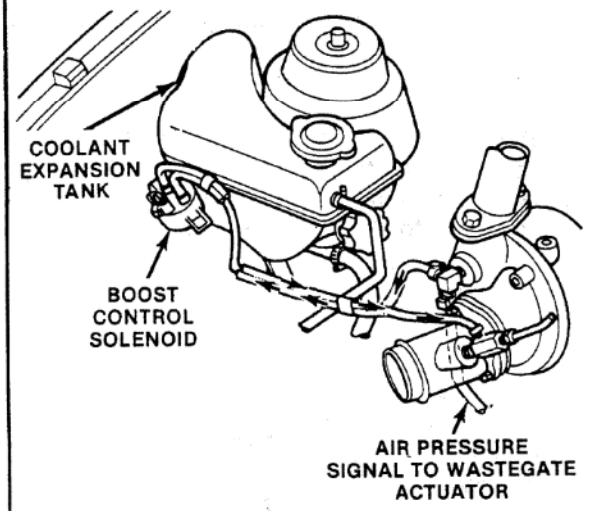
BOOST CONTROL

During turbocharger boost, more and more exhaust gases are created which spin the turbine and compressor wheels at an increasing rate. This gas flow to turbine speed increase cycle could continue until the boost became great enough to damage the engine if not controlled. A wastegate is used to limit the amount of boost and keep it within safe limits. Left uncontrolled, boost pressure can reach a point where engine damage could occur due to excessive detonation. The wastegate is located in the turbine housing and it allows exhaust gases to bypass the turbine wheel once maximum allowable boost pressure has been reached. Position of the wastegate is controlled by a diaphragm and spring actuator assembly that senses manifold pressure, and correctly positions the lever and valve assembly to obtain the desired amount of bypassed exhaust gases.



The amount of pressure applied to the diaphragm is controlled by a boost control solenoid located on the right side of the engine compartment in front of the cooling system expansion tank. Hoses connect the solenoid to the vacuum and pressure sides of the turbocharger. Function of the solenoid is controlled by the EECIV electronic control assembly.

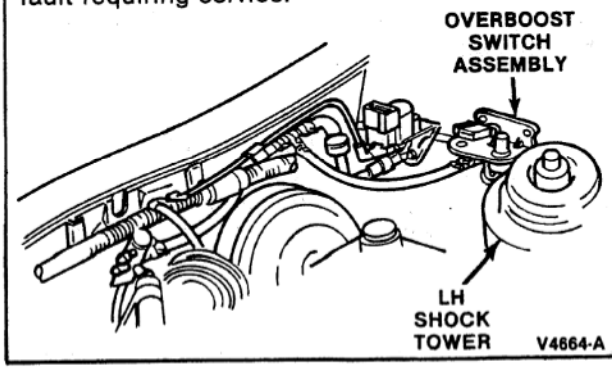
When boost pressures reach approximately 15 psi, the ECA will use the boost control solenoid to open the wastegate, by-passing exhaust gases away from the turbine blades.



OVERBOOST WARNING

If turbo boost rises above the safe limit, the driver is alerted to the condition through the overboost warning buzzer. The buzzer circuit is completed through a pressure sensitive switch located in the left rear corner of the engine compartment. The switch receives its signal through a hose connected to the vacuum tree, which is connected directly to the intake manifold. If pressure exceeds 18 psi, the switch contacts close and the warning buzzer sounds off.

NOTE: An overboost warning indicates a system fault requiring service.



REMOVAL AND INSTALLATION

TURBOCHARGER

Removal

NOTE: The turbocharger is serviced by replacement ONLY.

For diagnosis procedures, refer to Section 24-01 of this manual.

Before starting any turbocharger unit service/removal procedure, clean the area around the turbocharger assembly with a non-caustic solution.

Cover the openings of the engine assembly connections to prevent entry of foreign material while the turbocharger is off the engine.

When removing the turbocharger assembly, take special care not to bend, nick, or in any way damage the compressor wheel blades. Any damage may result in rotating assembly imbalance, and failure of the bearings and oil seal.

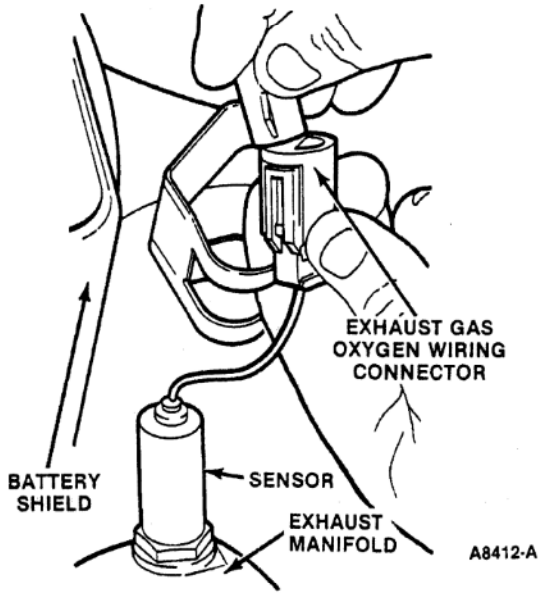
Any time a basic engine bearing (main bearing, connecting rod bearing, camshaft bearing) has been damaged in a turbocharged engine, the oil and oil filter should be changed as part of the service procedure. In addition, the turbocharger should be flushed with clean engine oil to reduce the possibility of contamination.

Interruption or contamination of the oil supply to the bearings in the center housing which support the rotating assembly can result in major turbocharger damage.

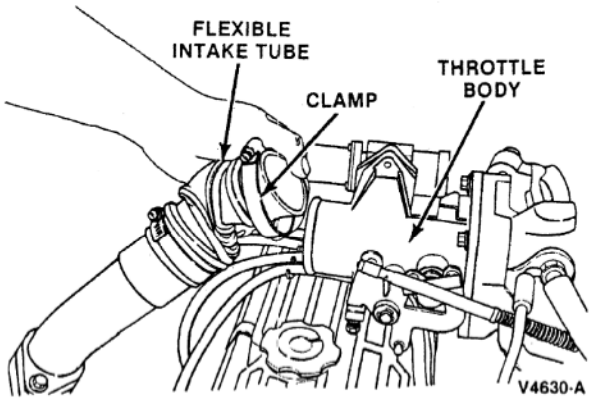
When changing oil and the oil filter on a turbocharged engine, or when performing any operation before starting the engine:

- Disconnect the ignition coil wire from the distributor.
- Crank the engine several times (not to exceed 30 seconds for each cranking interval) until the oil lamp goes out.
- Reconnect the ignition coil to the distributor. This procedure will aid the filling of the oil system.

1. Disconnect the battery negative cable and drain the cooling system. If necessary, refer to Section 27-03.
2. Disconnect the oxygen sensor wiring connector from the harness.



3. Loosen the hose clamp and disconnect the flexible hose from the throttle body.

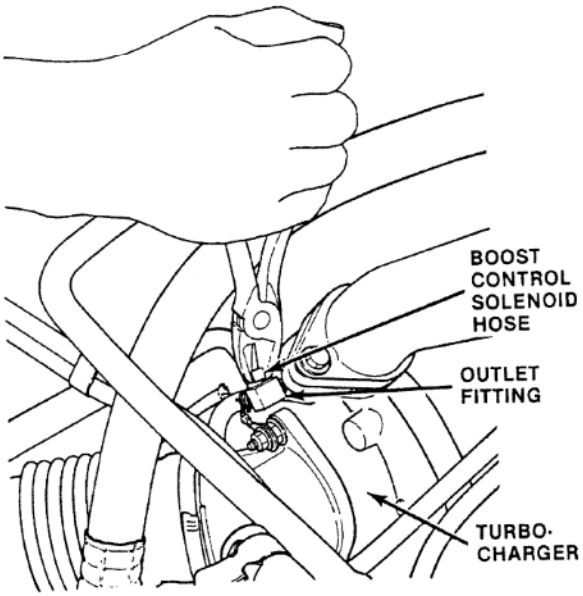


REMOVAL AND INSTALLATION

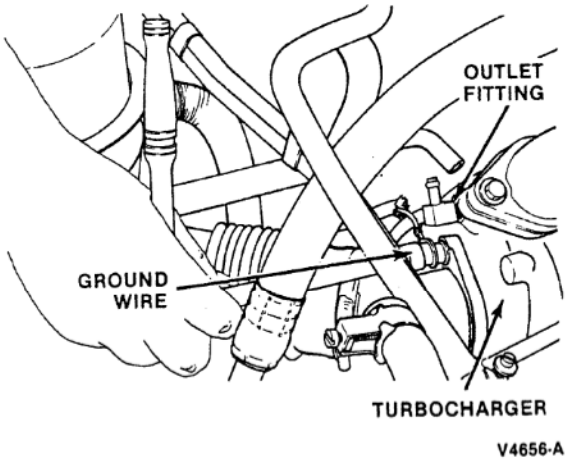
TURBOCHARGER

Removal (Continued)

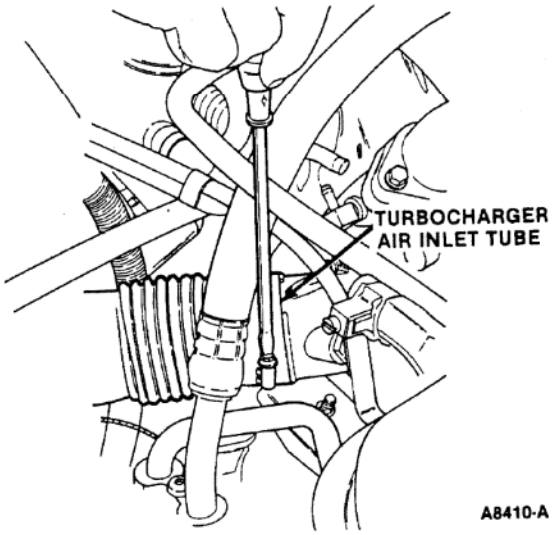
4. Disconnect the boost control solenoid hose at the turbocharger outlet fitting.



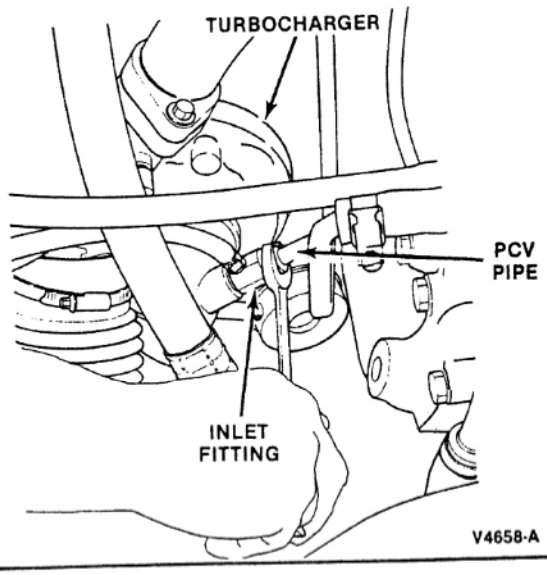
5. Disconnect the ground wire below the turbocharger outlet fitting.



6. Disconnect the turbocharger air inlet tube.



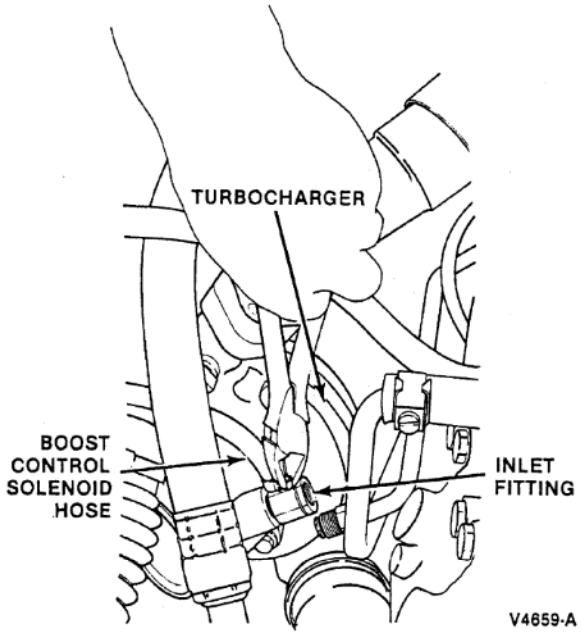
7. Disconnect the positive crankcase ventilation (PCV) pipe from the turbocharger inlet fitting.



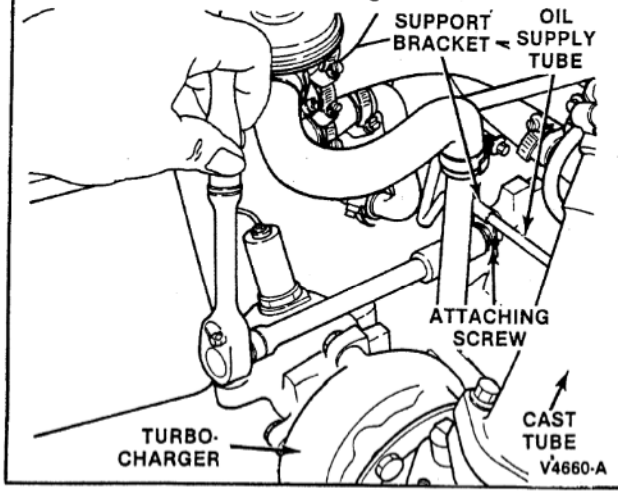
REMOVAL AND INSTALLATION

TURBOCHARGER
Removal (Continued)

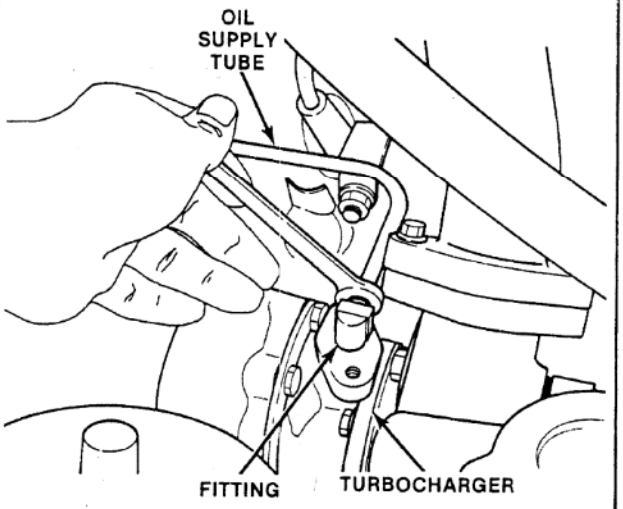
8. Disconnect the boost control solenoid hose from the turbocharger inlet fitting.



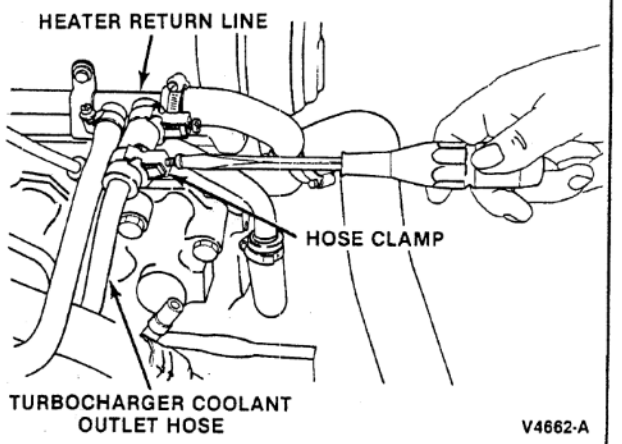
9. Remove the turbocharger oil supply tube routing bracket attaching nut.



10. Disconnect the oil supply tube from the turbocharger fitting.



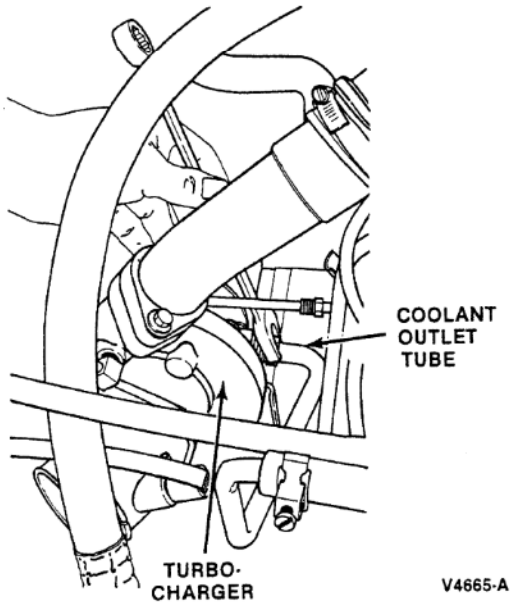
11. Loosen the hose clamp attaching the coolant outlet tube to the heater return line.

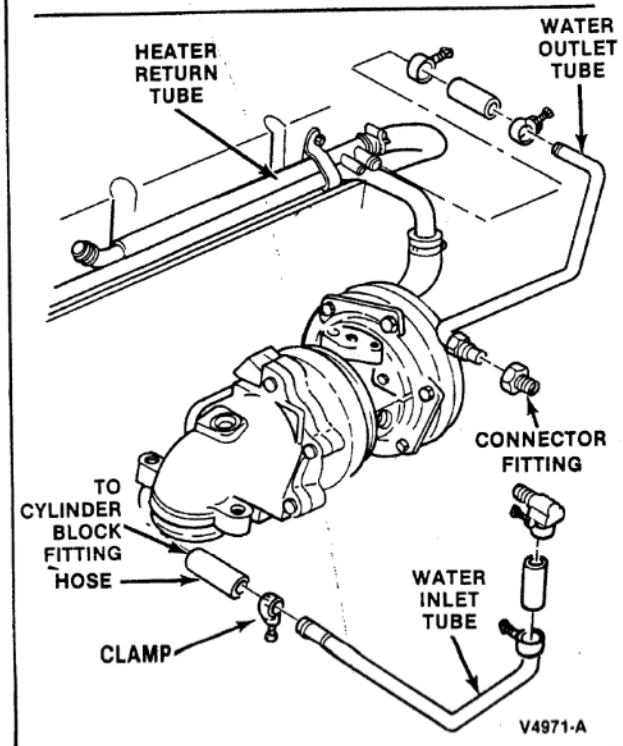


REMOVAL AND INSTALLATION

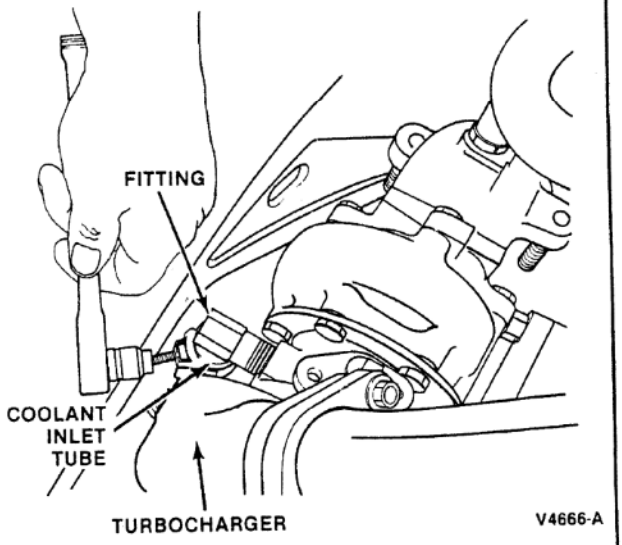
TURBOCHARGER
Removal (Continued)

12. Disconnect the coolant outlet tube from the turbocharger.

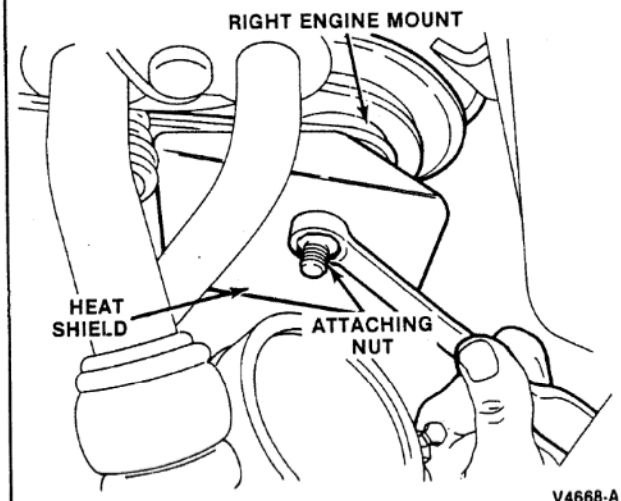




13. Loosen the hose clamp and disconnect the coolant inlet tube from the turbocharger fitting.



14. Loosen the nut attaching the heat shield to the top of the right engine mount.

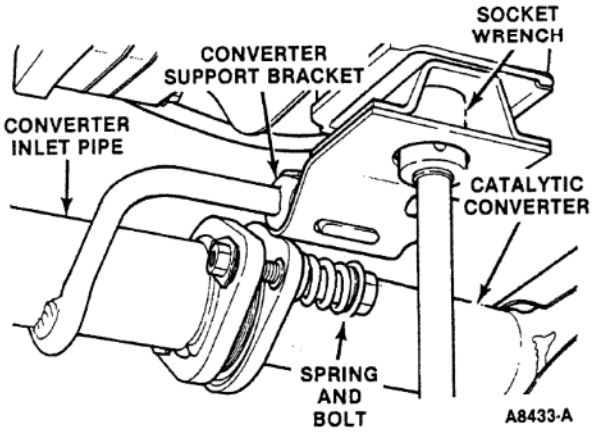


REMOVAL AND INSTALLATION

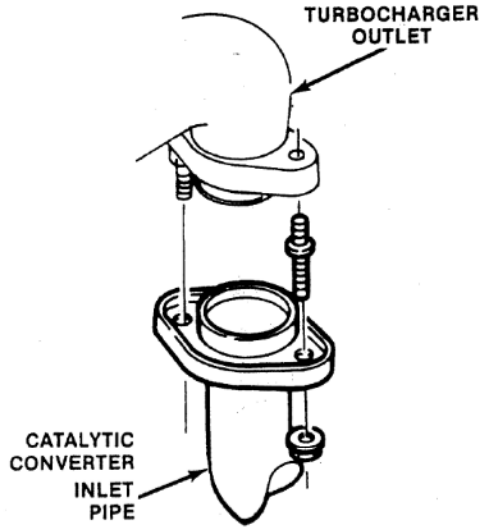
TURBOCHARGER

Removal (Continued)

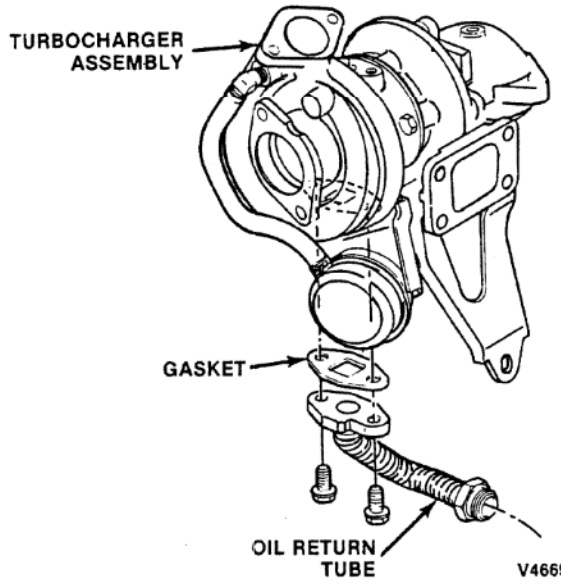
15. Raise the vehicle.
16. Remove the transmission mount center plate.



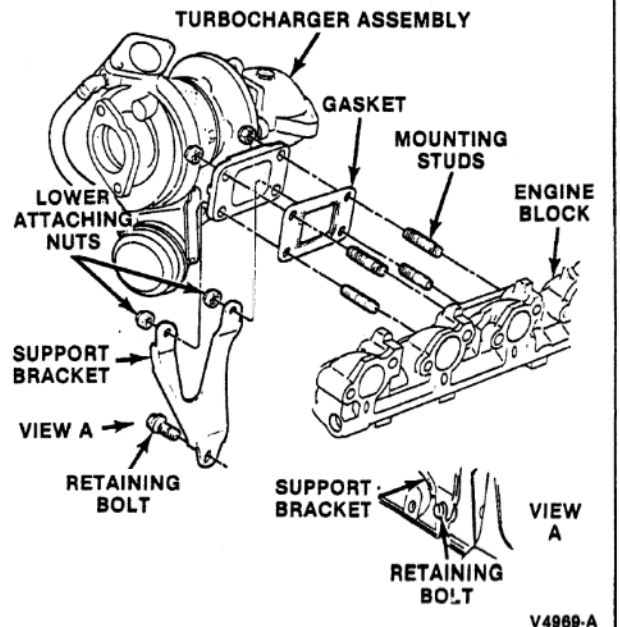
17. Remove the attaching nuts and disconnect the exhaust inlet pipe from the turbocharger.



18. Remove the attaching bolts, disconnect the turbocharger oil return tube and remove the gasket.



19. Remove the turbocharger lower attaching nuts.

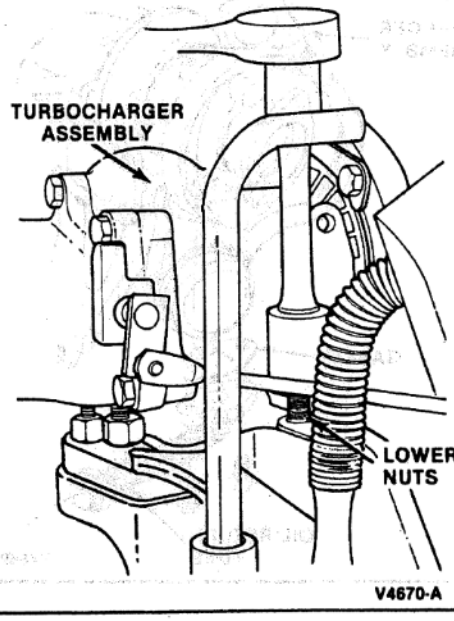


REMOVAL AND INSTALLATION

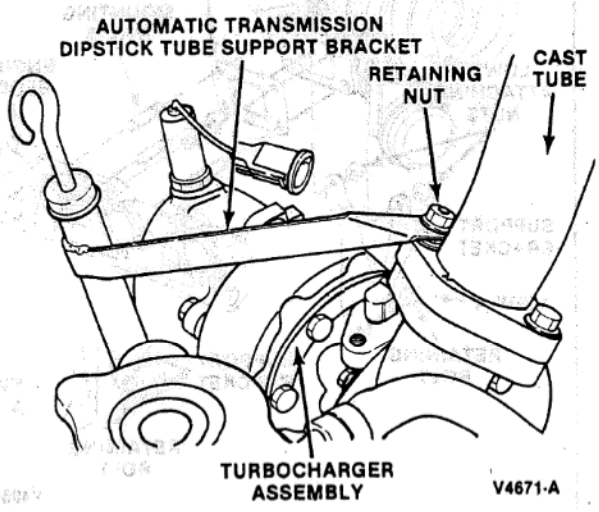
TURBOCHARGER

Removal (Continued)

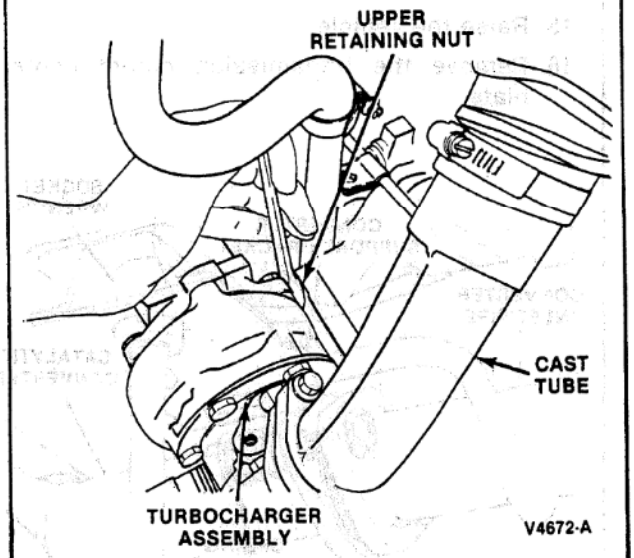
20. Remove the turbocharger support bracket bottom attaching bolt and remove the bracket.



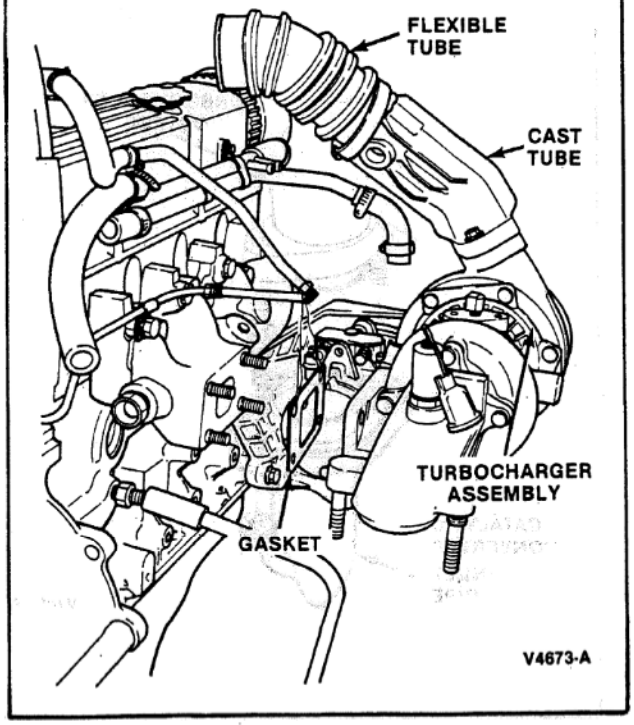
21. Partially lower the vehicle.
22. If equipped with an automatic transmission, remove the attaching nut and disconnect the dipstick tube support bracket from the cast tube flange.



23. Remove the turbocharger upper attaching nuts.



24. Remove the turbocharger, gasket, outlet tube and hose from the vehicle as an assembly outlet.

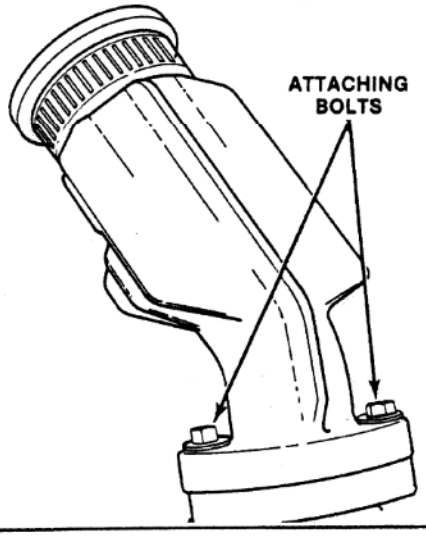


REMOVAL AND INSTALLATION

TURBOCHARGER

Removal (Continued)

25. Remove the attaching bolts and disconnect the outlet tube from the turbocharger.



Installation

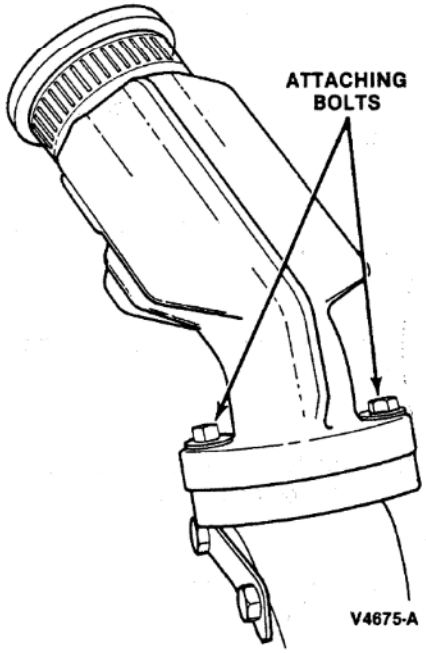
1. Position a new turbocharger gasket on the mounting studs. Be sure the head faces outward.
2. Install the turbocharger assembly on the four mounting studs.
3. Install the turbocharger bracket on the two lower studs. Start the two lower, then the two upper attaching nuts. Use new nuts.
4. Raise the vehicle on a hoist.
5. Install the turbocharger support bracket to block attaching bolt. Tighten the bolt to 38 to 54 N·m (28 to 40 lb-ft).
7. Install the muffler inlet pipe and retaining nuts. Tighten the nuts to 34 to 47 N·m (25 to 35 lb-ft).
8. Install the transmission mount center plate.
9. Tighten the turbocharger lower attaching nuts to 38 to 54 N·m (28 to 40 lb-ft).
10. Lower the vehicle.
11. Tighten the turbocharger upper attaching nuts to 38 to 54 N·m (28 to 40 lb-ft).
12. Tighten the nut attaching the heat shield to the right engine mount.
13. Connect the coolant inlet tube to the turbocharger fitting.
14. Connect the coolant outlet tube to the turbocharger.
15. Tighten the hose clamp attaching the coolant outlet tube to the heater supply line.
16. Connect the oil supply tube to the turbocharger fitting.
17. Install and tighten the oil supply tube support bracket attaching screw.
18. Connect the boost control solenoid hose to the turbocharger inlet fitting.
19. Connect the PCV pipe to the turbocharger fitting.
20. Connect the air intake hose from the vane air meter to the turbocharger.
21. Connect the ground wire below the turbocharger outlet fitting.
22. Connect the boost control solenoid hose at the turbocharger outlet fitting.

REMOVAL AND INSTALLATION

TURBOCHARGER

Installation (Continued)

23. Install the outlet tube and hose on the turbocharger. Tighten the attaching bolts.



24. Install the automatic transmission dipstick tube support bracket (if so equipped) on the outlet tube and tighten the attaching nut.

25. Connect the outlet hose to the throttle body and tighten the hose clamp.

26. Fill the cooling system. If necessary, refer to Section 27-03.

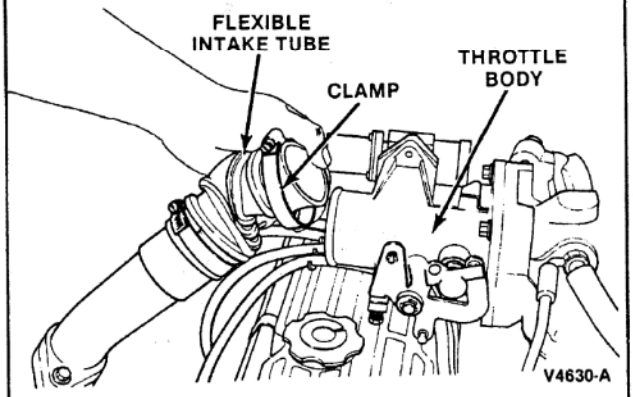
27. Connect the ground cable to the battery.

28. Start the engine and check for oil and air leaks.

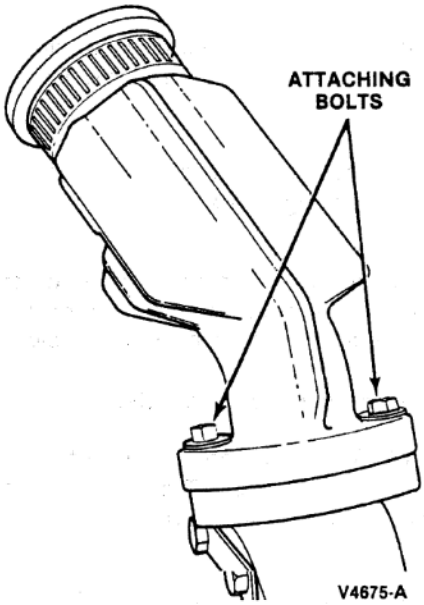
OUTLET TUBE AND HOSE

Removal

1. Disconnect the outlet hose from the throttle body.



2. Remove the outlet tube attaching bolts.



3. Remove the outlet tube and hose from the vehicle.
4. Loosen the hose clamp and disconnect the outlet hose from the outlet tube.

REMOVAL AND INSTALLATION

OUTLET TUBE AND HOSE

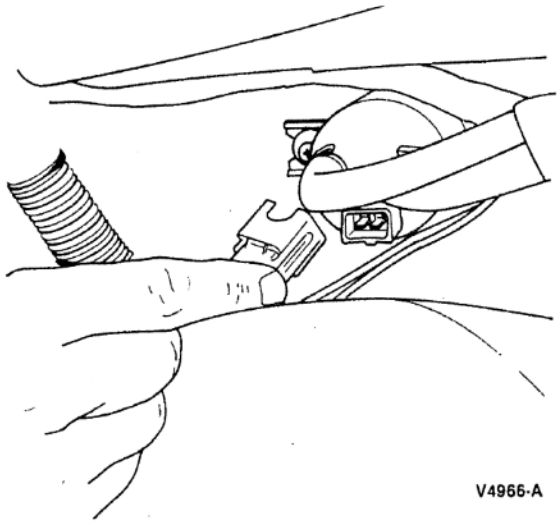
Installation

1. Connect the outlet hose to the outlet tube and tighten the hose clamp.
2. Position the outlet tube on the turbocharger and install the attaching bolts.
3. Connect the outlet hose to the throttle body and tighten the hose clamp.

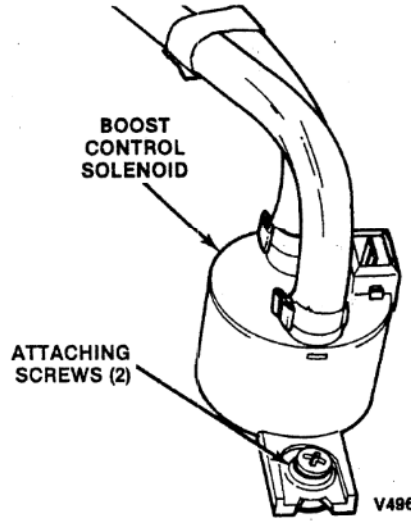
BOOST CONTROL SOLENOID

Removal

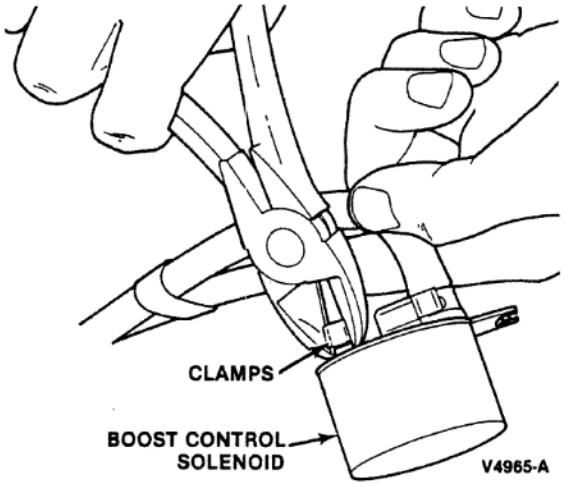
1. Disconnect the electrical connector.



2. Remove the boost control solenoid.



3. Cut the clamps and disconnect the hoses from the solenoid.

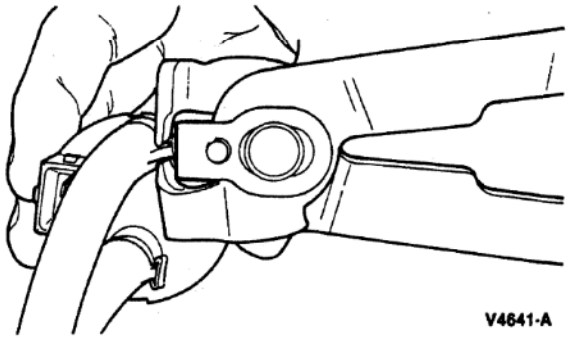


REMOVAL AND INSTALLATION

BOOST CONTROL SOLENOID

Installation

1. Connect the hoses. Install new clamps using Keystone Clamp Pliers T63P-9171-A, or equivalent.

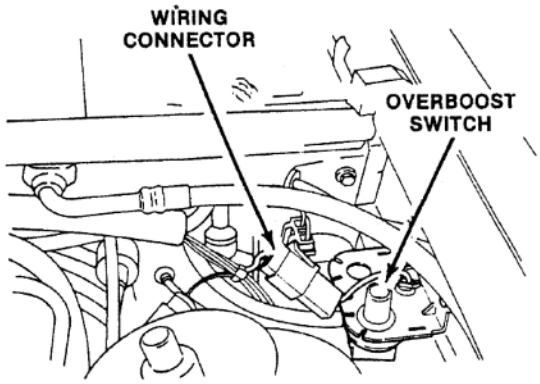


2. Position the solenoid and install the attaching screws.
3. Connect the electrical connector.

OVERBOOST WARNING SWITCH

Removal and Installation

The overboost warning switch is located in the left rear corner of the engine compartment. To remove the switch, disconnect the wiring connector and remove the attaching screws.



SECTION 24-50 FUEL TANKS AND LINES

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Fuel Tank Vapor Venting 3

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GENERAL SERVICE PROCEDURES

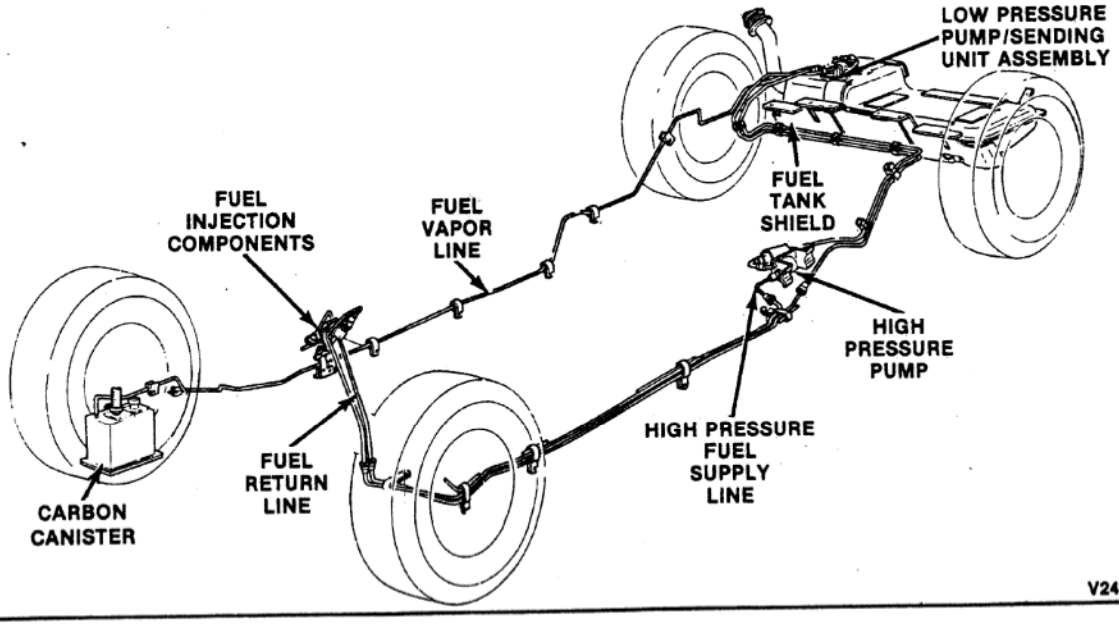
Fuel System Pressure Relief 12
Push Connect Fittings 12
5/16-Inch Fittings (Hair Pin Clip) 12
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Plastic Tube Repairs 14
Replacing Damaged Push Connectors 15
Replacing Damaged Steel Push-connect Type Ends 16

DESCRIPTION

GENERAL INFORMATION

The fuel tank is strap mounted at the rear of the vehicle and contains the fuel injection system low pressure pump/fuel gauge sending unit assembly. The fuel drawn from the tank by this pump is routed to a high pressure pump mounted on the left rear body side rail. Fuel from the high pressure pump feeds the fuel injection manifold and the fuel injectors.

Pressure within the system is controlled by a pressure regulator attached to the fuel injection manifold. The regulator maintains system pressure by allowing a controlled amount of fuel to leave the high pressure system and return to the tank. The fuel return system and pressure system components are connected with nylon fuel line and lengths of steel fuel line.



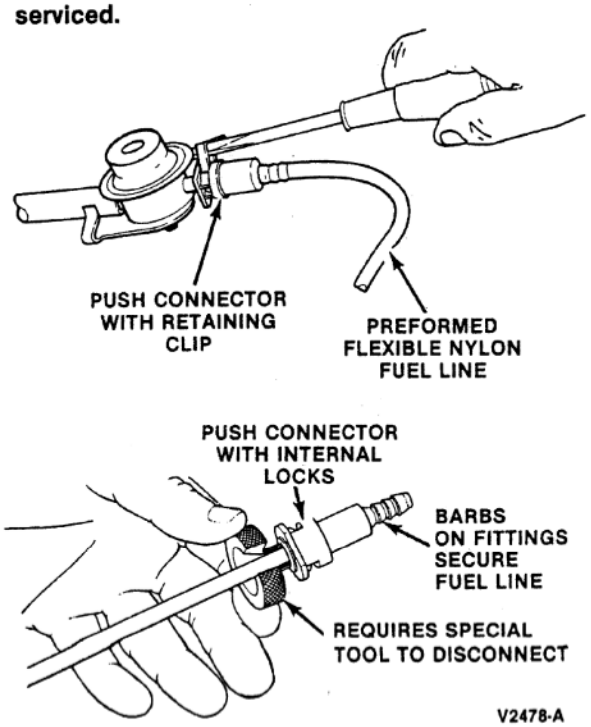
DESCRIPTION

FUEL LINES

The nylon fuel lines are preformed to the body for proper routing and are attached to the various fuel system components with push connectors. Although they are preformed, the nylon fuel lines have a limited amount of flexibility. They can be repositioned and bowed along a long radius. A nylon fuel line must never be bent along a short radius that causes kinking.

During fuel system service, two types of nylon fuel line connectors will be encountered. The 5/16″ fuel line is connected to steel fuel line fittings with a push connector that used a "hair-pin" retention clip. The 1/4″ fuel line is connected with a "duck-bill" retention clip. Either fuel line can be disconnected by releasing the retention clip. The 5/16″ fuel line is disconnected by removing the clip. The 1/4″ fuel line is disconnected using a special tool or by removing the retention clip. For further details refer to the General Procedures in this section.

CAUTION: Fuel supply lines will remain pressurized for some period of time after the engine is shut off. System pressure must be relieved before any component in the fuel system is serviced.



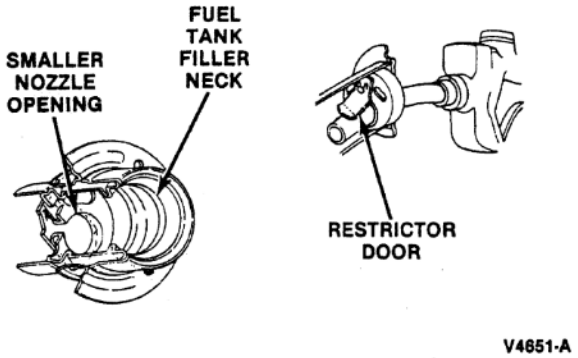
CAUTION: The nylon fuel lines can be damaged by torches, welding sparks, grinding and other operations which involve heat and high temperatures. When performing any service or repair that involves heat and high temperatures, position fuel system components (especially fuel lines) where they will not be damaged. Remove nylon fuel tubes from the vehicle if a torch or high-heat-producing equipment is to be used for service in the following areas:

- **Exhaust or suspension components close to fuel tubes**
- **Floor pan under vehicle and inside the passenger compartment**
- **Underbody frames, rails and crossmembers**
- **Firewall or dash panel under vehicle or inside the passenger compartment**

FUEL FILLER

The filler neck has a restricted opening that will not allow usage of leaded fuel.

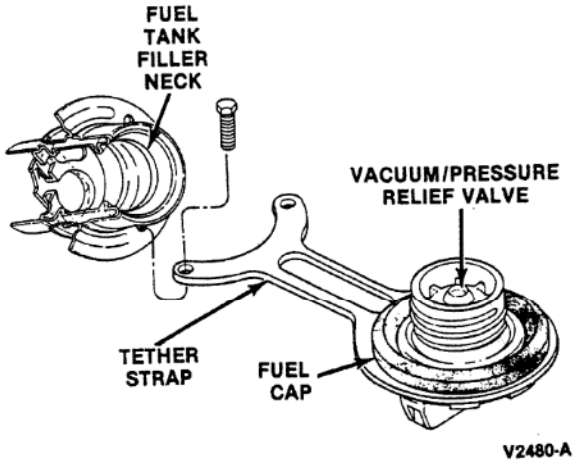
The restricted fuel filler is manufactured as an assembly, and is replaced only as a complete assembly with the filler neck.



DESCRIPTION

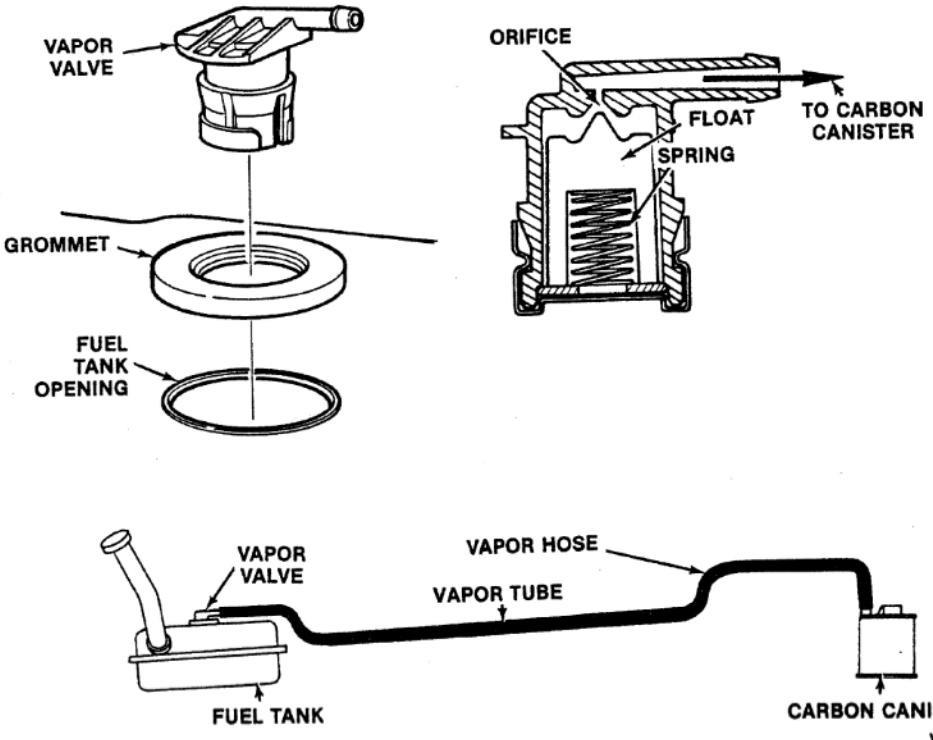
PRESSURE/VACUUM RELIEF FUEL CAP

The fuel cap contains an integral pressure and vacuum relief valve. The vacuum valve acts to allow air into the fuel tank to replace the fuel as it is used. The vacuum relief valve opens after a vacuum of 3.4kPa (– 0.5 psi). The pressure valve acts as a backup pressure relief valve in the event the normal venting system is overcome by excessive generation of internal pressure or restriction of the normal venting system. The pressure relief range is 11.1-14.4 kPa (1.6-2.1 psi). Fill cap damage or contamination that stops the pressure vacuum valve from working may result in deformation of the fuel tank. Care should always be taken to use a proper fill cap in good working order.



FUEL TANK VAPOR VENTING

Fuel vapor in the fuel tank is vented to the carbon canister through the vapor valve assembly. The valve is mounted in a rubber grommet at a central location in the upper surface of the fuel tank. A vapor space between the fuel level and the tank upper surface is combined with a small orifice and front float-off valve in the vapor valve assembly to prevent liquid fuel from passing to the carbon canister. The vapor space also allows for thermal expansion of the fuel.



REMOVAL AND INSTALLATION

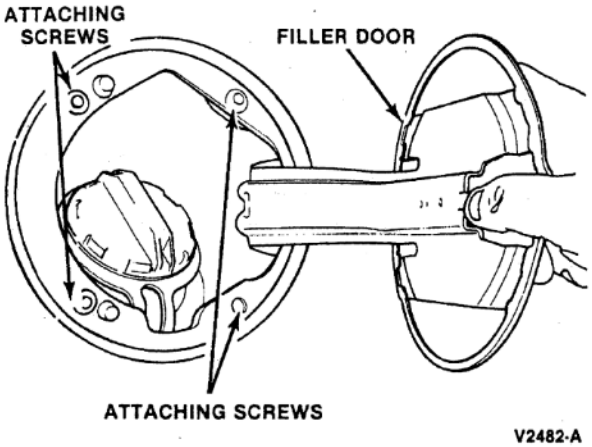
FUEL TANK

Removal

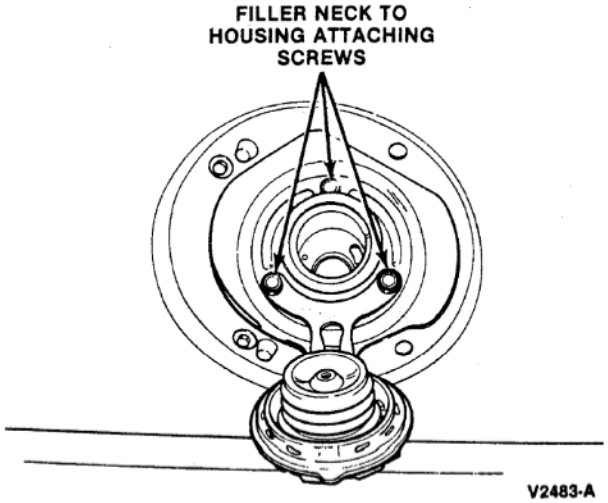
1. Disconnect the battery negative cable.
2. Release pressure from the fuel system. If necessary, refer to the procedure in this section.
3. Remove as much fuel as possible from the tank using a safety-approved pump.

CAUTION: The fuel level in the tank must be below the level of the filler neck.

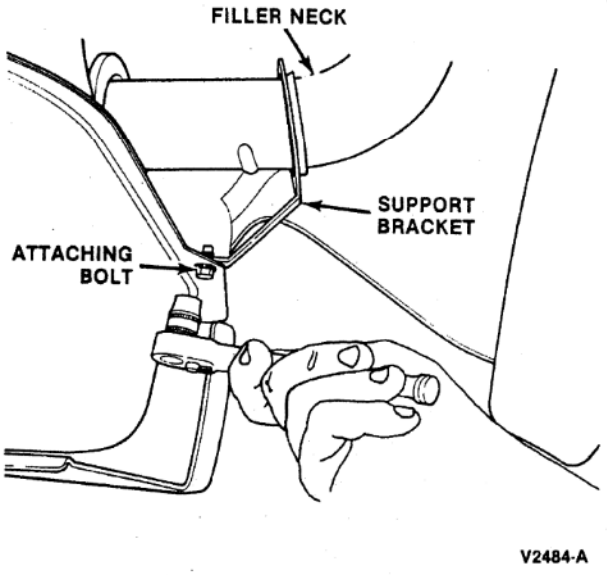
4. Remove the filler door/filler neck housing attaching screws and the filler door.



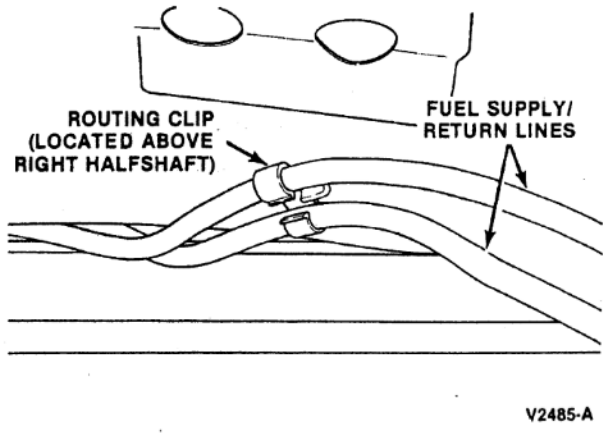
5. Remove the filler neck to housing attaching screws. Remove the filler cap and tether assembly.



6. Raise the vehicle.
7. Remove the filler neck support bracket attaching bolt.



8. Disengage the fuel supply and return lines from the routing clip located above the right halfshaft.

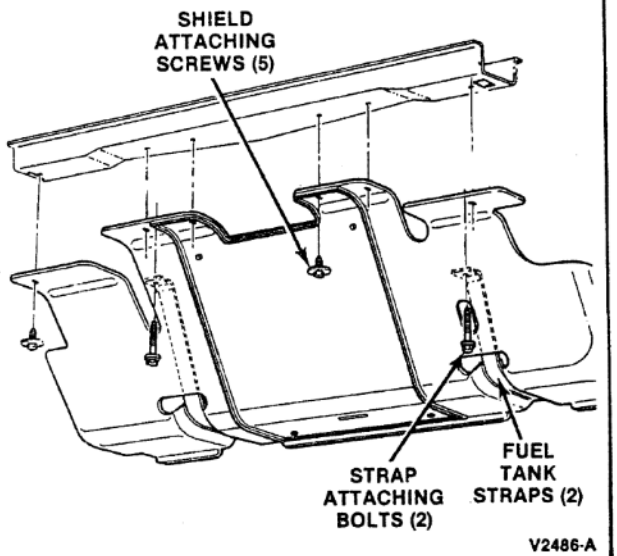


REMOVAL AND INSTALLATION

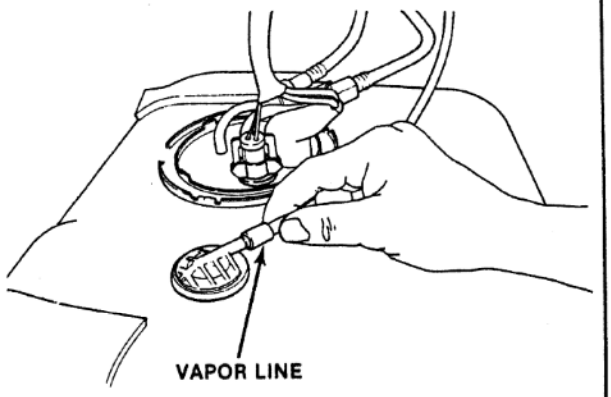
FUEL TANK

Removal (Continued)

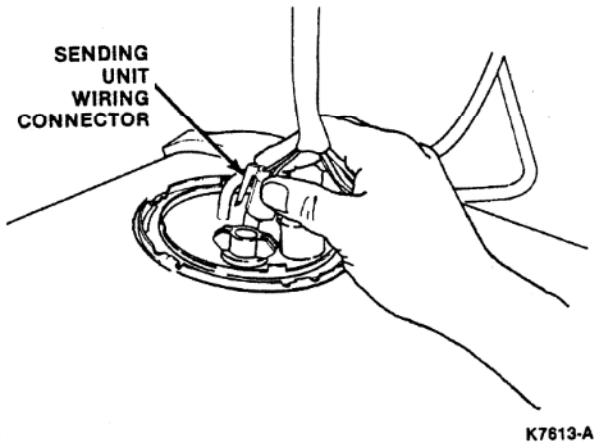
9. Support the fuel tank on a suitable jack. Secure the tank to the jack with safety straps.
10. Remove the fuel tank shield attaching screws and the fuel tank strap attaching bolts.



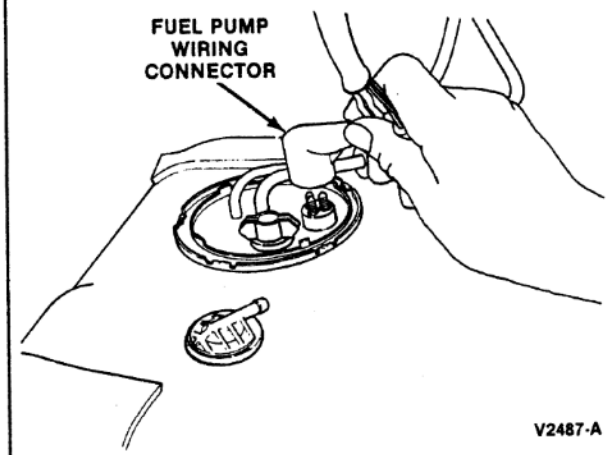
11. Lower the fuel tank slightly and disconnect the following:
    - Vapor line



- Fuel level sending unit connector



- Fuel pump wiring connector



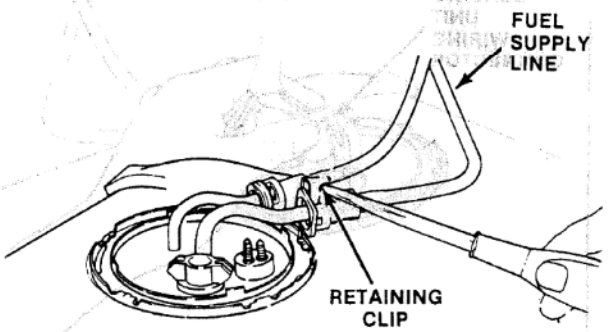
REMOVAL AND INSTALLATION

FUEL TANK

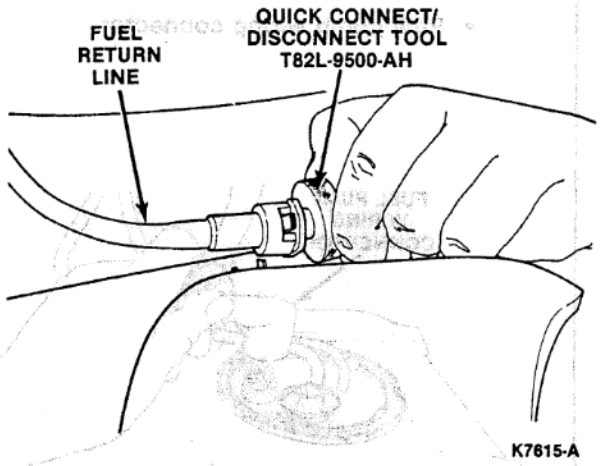
Removal (Continued)

- Fuel supply line

NOTE: If necessary, refer to the hairpin clip removal procedure in this section.



- Fuel return line

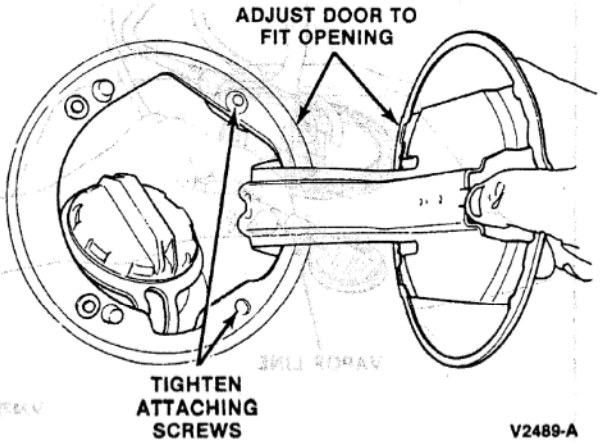


NOTE: Use Fuel Line Remover T82L-9500-AH, or equivalent. If necessary, refer to the procedure in this section for tool usage or the alternate procedure that does not require the tool.

12. Move the fuel tank to the left to separate it from the filler neck.
13. Push the tank rearward to clear the tank shield. Lower it from the vehicle.

Installation

1. Raise the fuel tank.
2. Coat the filler neck with SAE 10W-40 engine oil. Engine oil only must be used.
3. Guide the filler neck into the tank grommet and push the tank into position.
4. Connect the following:
   - Vapor return line
   - Fuel supply line
   - Fuel return line
   - Fuel pump wiring connector
   - Fuel level sending unit connector
5. Raise the tank into position. Position the tank straps and install the attaching bolts.
6. Remove the jack used to support the fuel tank.
7. Install the filler neck support bracket attaching bolt.
8. Install the fuel supply and return lines in the routing clip.
9. Lower the vehicle.
10. With the filler neck and filler cap tether in position, install the filler neck attaching screws.
11. Install the filler neck housing attaching screws.
12. Position the filler door and install the attaching screws. Before tightening the filler door attaching screws, adjust the position of the door to fit the body panel opening.



REMOVAL AND INSTALLATION

FUEL TANK

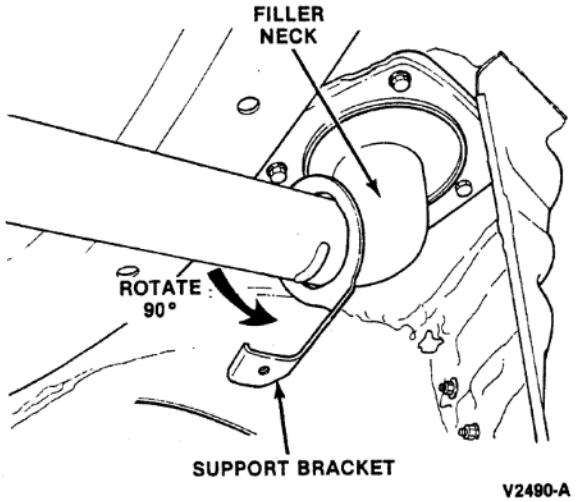
Installation (Continued)

13. If fuel was removed from the tank, pump it back into the tank.
14. Connect the battery negative cable.
15. Start the engine. Check for leaks at the tank fuel lines.

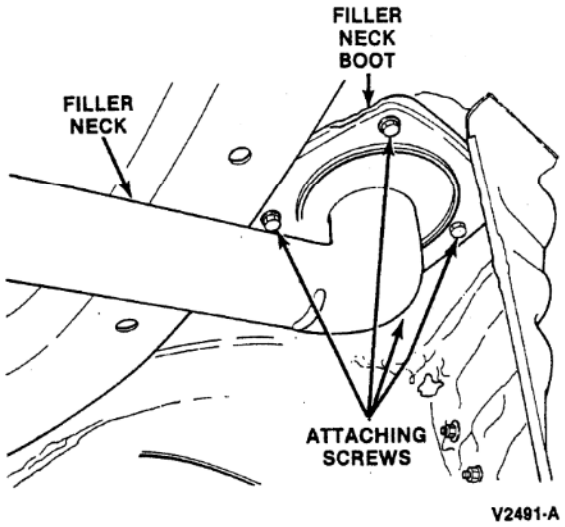
FILLER NECK

Removal

1. Remove the fuel tank. If necessary, refer to the procedure in this section.
2. Remove the support bracket from the filler neck. Rotate the bracket ninety degrees to disengage the bracket from the filler neck.

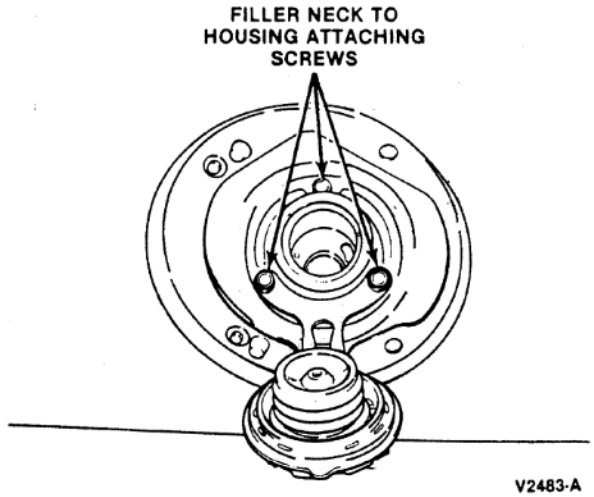


3. Remove the attaching screws and the filler neck boot.



4. Lower the vehicle.

5. Remove the filler cap tether and filler neck flange attaching screws.



6. Remove the filler neck.

REMOVAL AND INSTALLATION

FILLER NECK

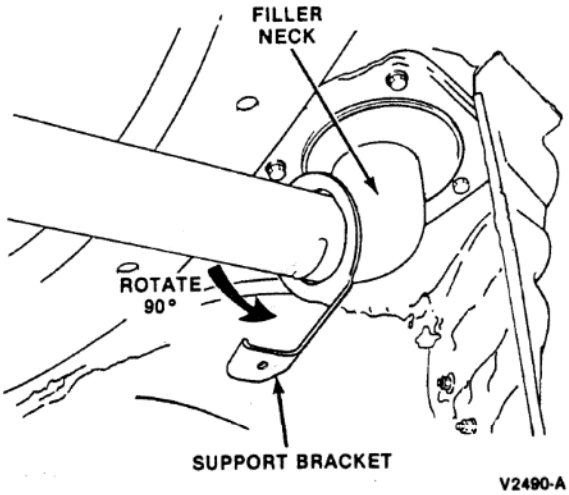
Installation

1. Coat the filler neck flange with RTV, or equivalent sealant.
2. Install the filler neck.
3. Install the filler cap tether and filler neck flange attaching screws.
4. Raise the vehicle.
5. Install the filler neck boot and the attaching screws.
6. Install the filler neck support bracket.
7. Install the fuel tank. If necessary, refer to the procedure in this section.

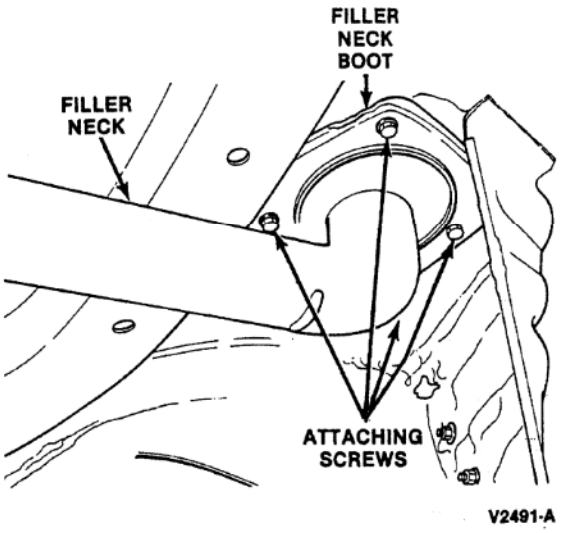
FILLER NECK HOUSING

Removal

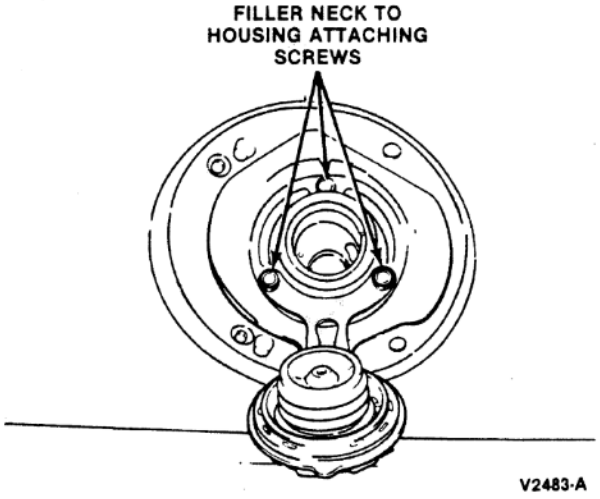
1. Remove the fuel tank. If necessary, refer to the procedure in this section.
2. Remove the support bracket from the filler neck. Rotate the bracket ninety degrees to disengage from the filler neck.



3. Remove the attaching screws and the filler neck boot.



4. Lower the vehicle.
5. Remove the filler cap tether and filler neck flange attaching screws.



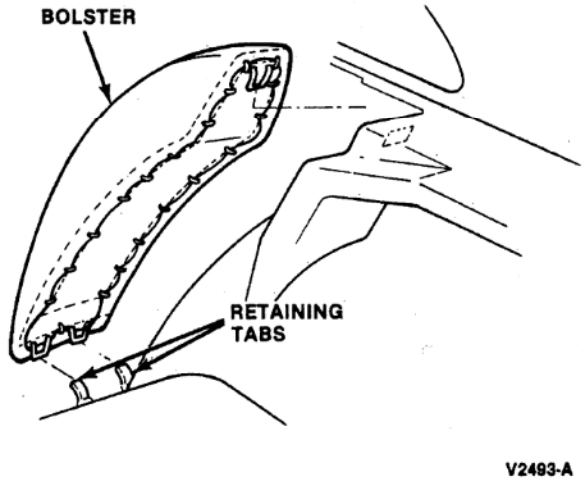
6. Lower the rear seat backs and remove the luggage compartment carpeting.
7. Push the right side rear seat back upward into position and pull the seat cushion forward.

REMOVAL AND INSTALLATION

FILLER NECK HOUSING

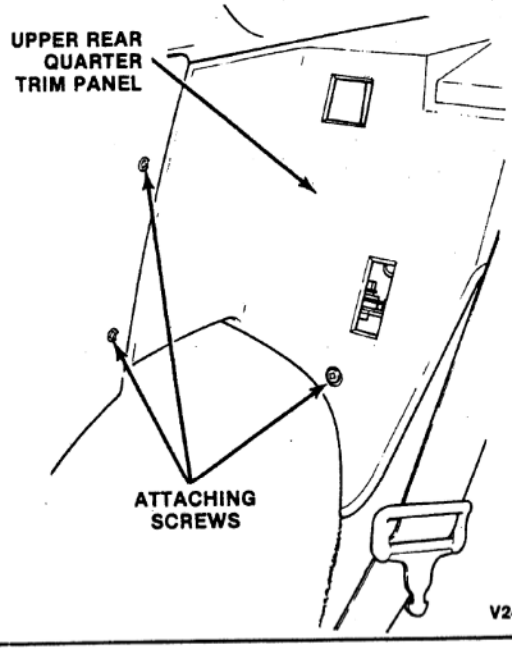
Removal (Continued)

8. At the bottom of the right side seat bolster, bend the bolster retaining tabs upward.

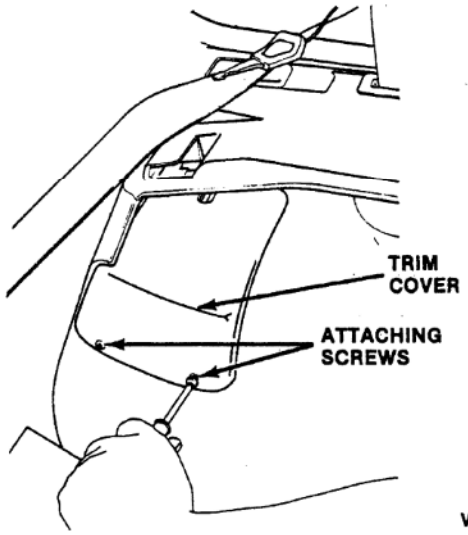


Push upward on the bolster to disengage the upper retainer and remove the bolster.

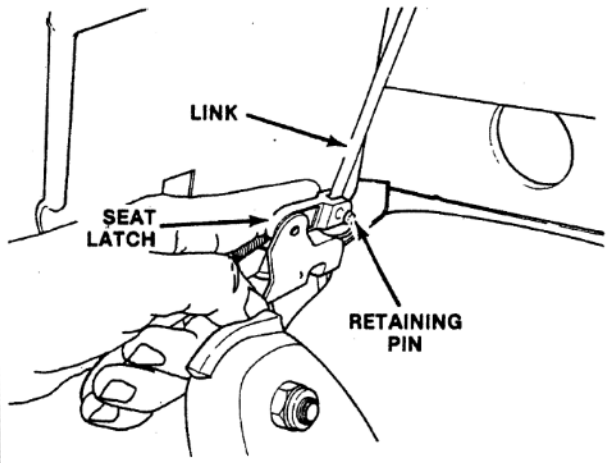
9. Remove three upper rear quarter trim panel attaching screws.



10. Remove the shock tower trim panel.



11. Remove the seat latch link retaining pin.

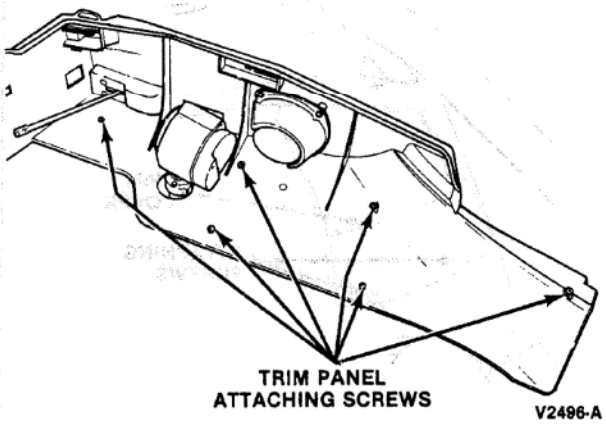


REMOVAL AND INSTALLATION

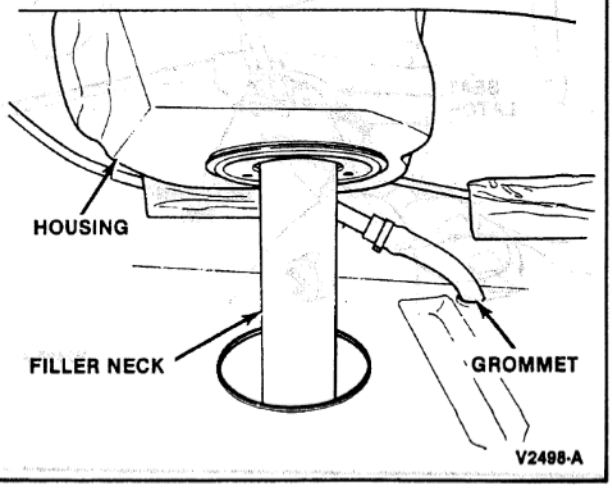
FILLER NECK HOUSING

Removal (Continued)

12. Remove six upper rear quarter trim panel attaching screws.



13. Remove the lower rear quarter trim panel push retainer. The retainer is located in the rear corner of the panel behind the carpet covering the jack.
14. Remove the lower rear quarter trim panel.
15. Remove the filler neck and housing as an assembly. Pull the housing drain tube out of the floor pan grommet as the housing is removed.



16. Remove the filler neck from the housing.

Installation

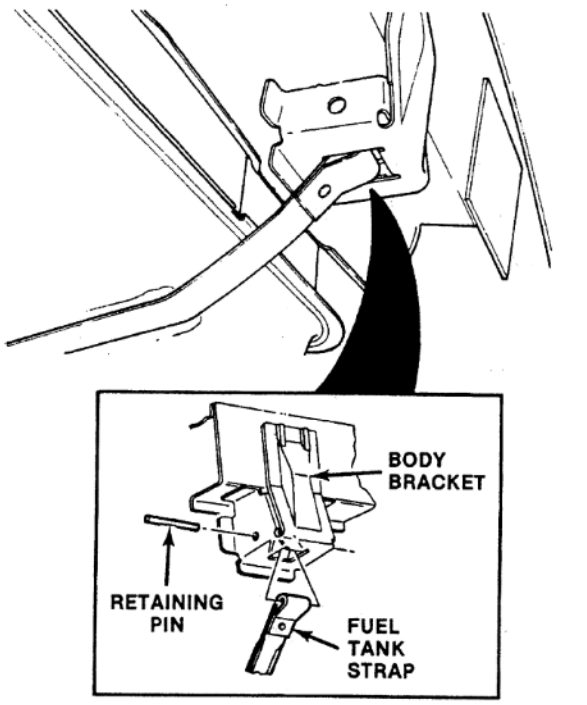
1. Install the filler neck and housing as an assembly. Make sure the housing drain is pushed through the floor pan grommet. Silicone spray on the grommet will aid installation.
2. Install the lower rear quarter trim panel. Make sure the upper edge of the panel is positioned under the upper rear quarter trim panel.
3. Install the lower rear quarter trim panel push retainer.
4. Install the six upper rear quarter trim panel attaching screws.
5. Position the seat back latch link and install the retaining pin.
6. Install the shock tower cover.
7. Install the three upper rear quarter trim panel attaching screws.
8. Position the seat bolster, push inward at the top and reach behind the trim panel with a screwdriver to snap the retainer into position.
9. Push inward on the lower end of the bolster and bend the retaining tabs downward.
10. Position the rear seat cushion and leave the rear seat back down.
11. Install the luggage compartment carpeting.
12. Apply RTV, or equivalent sealant, on the filler neck flange. Install the attaching screws.
13. Raise the vehicle.
14. Install the filler neck boot and the attaching screws.
15. Install the filler neck support bracket.
16. Install the fuel tank. If necessary, refer to the procedure in this section.

REMOVAL AND INSTALLATION

FUEL TANK STRAPS

Removal

NOTE: The fuel tank straps may be removed and/or replaced without removing the fuel tank. The tank straps can be removed one at a time if the tank is properly supported.



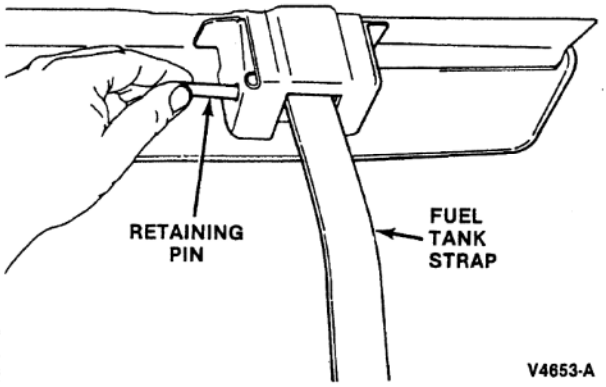
V2499-A

1. Raise the vehicle and support the fuel tank using a suitable jack.
2. Remove the strap attaching bolt.
3. Push the hinged end of the strap upward into the body bracket until the hinge pin aligns with the body bracket hole.

   There is a guide and stop inside the bracket to assist in aligning the strap for removal and installation of the pin.
4. Push the pin through the bracket using a pin punch or pencil magnet.

Installation

1. Position the strap in the body bracket until the strap loop is aligned with the hole in the bracket.
2. Insert the strap pin through the body bracket and into the strap loop.



V4653-A

3. Pull the strap downward until the pin is fully seated on the bottom of the bracket.

CAUTION: The pin must rest flat against the bottom of the bracket. If the pin is not fully seated, the fuel tank could be damaged. Attempt to position the pin so that it will seat properly. If unsuccessful, remove the pin and strap. Check for and remove any obstructions that may be inside the bracket. Check to be sure the pin is the correct length.

4. Install the strap attaching bolt. Tighten the attaching bolt to 28 to 40 N·m (21 to 30 lb-ft).

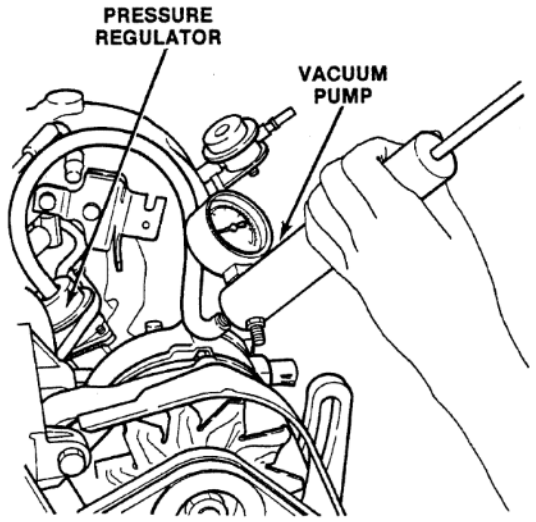
GENERAL SERVICE PROCEDURES

FUEL SYSTEM PRESSURE RELIEF

CAUTION: Fuel supply lines will remain pressurized for some period of time after the engine is shut off. System pressure must be relieved before any component in the fuel system is serviced.

Before Opening the Fuel Supply System, Relieve Fuel Pressure as Follows:

1. Remove fuel tank cap.
2. Disconnect the vacuum hose from the fuel pressure regulator located on the engine fuel rail.
3. Using a hand vacuum pump, apply about 84.2kPa (25 in. Hg) of vacuum to the pressure regulator.



A8434-A

Fuel pressure will be released into the fuel tank through the fuel return hose.

NOTE: When using a vacuum pump to relieve system pressure, it may take up to 3 minutes, to bleed system pressure.

PUSH-CONNECT FITTINGS

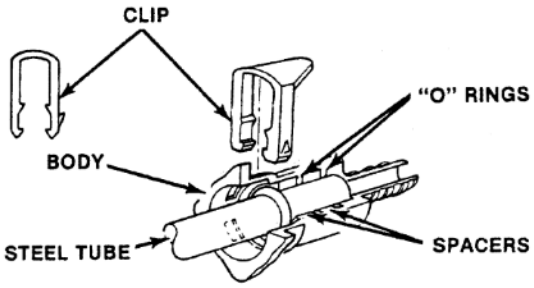
Push-connect fittings are designed with two different retaining clips. The fittings used to connect 5/16-inch nominal diameter metal tubing use a "hairpin" clip. The fittings used with 1/4-inch nominal diameter metal tubing uses a "duck bill" clip. Each type of fitting requires different service procedures.

Disconnect all push-connect fittings from components (pump, filter, engine) prior to component removal. The push connect fittings that connect flexible fuel lines to the fuel tank sender cannot be disconnected until the tank is partially lowered.

5/16-INCH FITTINGS (HAIR PIN CLIP)

Removal

CAUTION: Fuel supply lines will remain pressurized for some period of time after the engine is shut off. System pressure must be relieved before any component in the fuel system is serviced.



V3587-A

1. Inspect visible internal portion of fitting for dirt accumulation. If more than a light coating of dust is present, clean the fitting before disassembly.
2. Some adhesion between the seals in the fitting and the tubing will occur with time. To separate, twist the fitting on the tube, then push and pull the fitting until it moves freely on the tube.

GENERAL SERVICE PROCEDURES

5/16-INCH FITTINGS (Continued)

3. Remove "hairpin" type clip from fitting by first bending the shipping tab downward so that it will clear the body. Next, (using hands only) spread the two clip legs about 3.2 mm (1/8 in.) each to disengage the body and push the legs into the fitting. Complete removal is accomplished by lightly pulling from the triangular end of the clip and working it clear of the tube and fitting.

CAUTION: Do not use any tools.

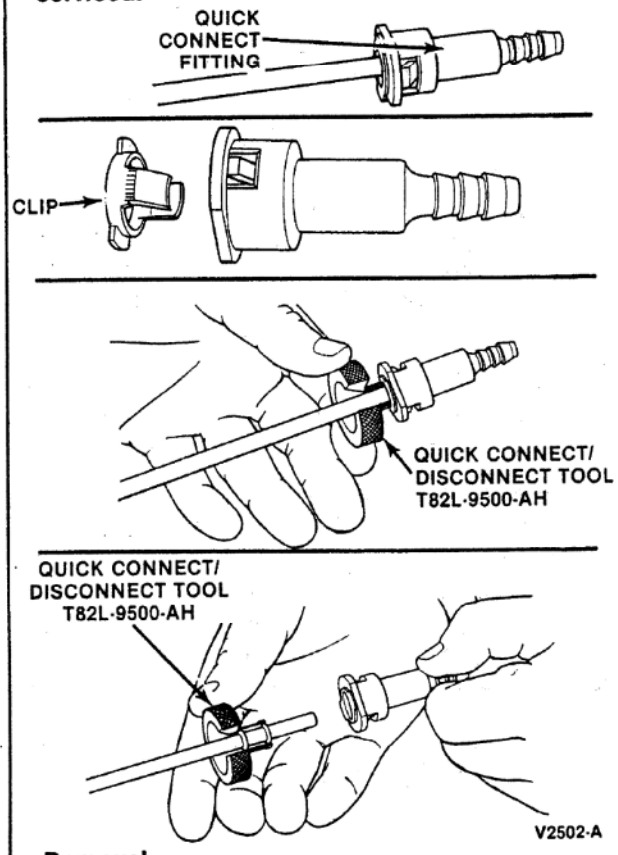
4. Grasp the fitting and hose assembly and pull away from the metal tube to remove the fitting.
5. When fitting is removed from the tube end, inspect the fitting and tube for any internal parts that may have been dislodged from the fitting. Reinstall any loose internal parts immediately, using the mating tube to insert the parts.

Installation

1. Do not reuse the original clip. To install the new clip, insert clip into any two adjacent openings with the triangular portion pointing away from the fitting opening. Install clip to fully engage the body (legs of "hairpin" clip locked on outside of body). Piloting with an index finger is necessary.
2. Before reinstalling fitting on the tube, wipe tube end with a clean cloth. Inspect the inside of the fitting to ensure it is free of dirt and/or obstructions.
3. To reinstall the fitting onto the tube, align the fitting and tube and push the fitting onto the tube end. When the fitting is engaged, a definite click will be heard. Pull on fitting to ensure it is fully engaged.

1/4-INCH FITTINGS (DUCK BILL CLIP)

CAUTION: Fuel supply lines will remain pressurized for some period of time after the engine is shut off. System pressure must be relieved before any component in the fuel system is serviced.



Removal

This fitting consists of a body, spacers, O-rings and a "duck bill" retaining clip. When disassembly is required for service, use one of the following two methods:

Preferred Method

To disengage the tube from the fitting, align the slot on push connect disassembly Tool T82L-9500-AH, or equivalent, with either tab on the clip (90 degrees from the slots on side of fitting) and insert the tool. This disengages the "duck bill" from the tube. With the tool properly installed, pull the fitting off the tube.

GENERAL SERVICE PROCEDURES

1/4-INCH FITTINGS (Continued)

NOTE: Only moderate effort is required if the tube has been properly disengaged. Use hands only.

After disassembly, inspect and clean the tube sealing surface. Also inspect the inside of the fitting and the tube for any internal parts that may have been dislodged from the fitting. Any loose internal parts should be immediately reinstalled, using the mating tube to insert the parts to the retaining clip. If the retaining clip appears to be damaged, replace it.

NOTE: Some fuel tubes have a secondary bead which aligns with the outer surface of the clip. These beads can make tool insertion difficult. If there is extreme difficulty, use the alternate disassembly method described below.

Alternate Method

This method of disassembly disengages the retaining clip from the fitting body.

Use a pair of narrow pliers (6-inch channel lock pliers are ideal). The pliers must have a jaw width of 5 mm (0.2 in.) or less.

Align the jaws of the pliers with the openings in the side of the fitting case and compress the portion of the retaining clip that engages the fitting case. This disengages the retaining clip from the case. (Often one side of the clip will disengage before the other. It is necessary to disengage the clip from both openings.) Pull the fitting off the tube.

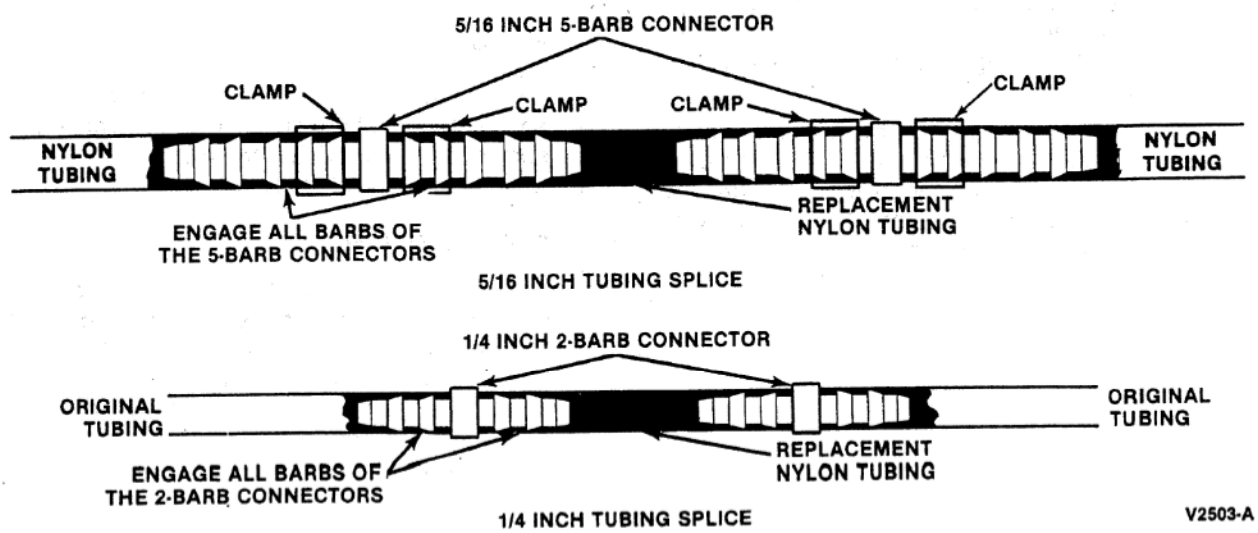
NOTE: Only moderate effort is required if the retaining clip has been properly disengaged. Use hands only.

The retaining clip will remain on the tube. Disengage the clip from the tube bead and remove.

Installation

1. Do not reuse the retaining clip. Install the new replacement clip into the body by inserting one of the retaining clips serrated edges on the duck bill portion into one of the window openings. Push on the other side until the clip snaps into place.
2. Before reinstalling fitting on the tube, wipe tube end with a clean cloth. Inspect the inside of the fitting to ensure it is free of dirt and/or obstructions.
3. To reinstall the fitting onto the tube, align the fitting and tube and push the fitting onto the tube end. When the fitting is engaged, a definite click will be heard. Pull on fitting to ensure it is fully engaged.

PLASTIC TUBE REPAIRS



GENERAL SERVICE PROCEDURES

PLASTIC TUBE REPAIRS (Continued)

CAUTION: Ford-approved nylon fuel tubing is made from material which has been tested and proven to be acceptable for use with commercially available fuels. It is also resistant to most environmental conditions. Avoid using alternate tubing materials. Use of non-approved tubing could pose a hazard in service.

CAUTION: Nylon fuel tube must not be repaired using hose and hose clamps. Push-connect fittings cannot be repaired except to replace the retaining clips. Should the plastic tubes, push-connect fittings or steel tube ends become damaged and leak, use approved service parts to service the fuel lines.

Vehicles equipped with nylon fuel tubes and push-connect fittings have three types of service that can be performed to the fuel lines; replacing nylon tubing (splicing nylon to nylon), replacing push connector retainer clip, and replacing damaged push connect tube end. These three methods follow:

Splicing Nylon to Nylon

1. Relieve fuel system pressure. If necessary, refer to the procedure in this section.
2. Cut out the damaged section of tubing and retain as a guide.
3. Cut a section of nylon service tubing (type 11 or 12 available in 1/4 and 5/16-inch sizes) to the same length as the damaged section of tubing.
4. Select the proper (1/4 or 5/16-inch) barbed connectors. Two connectors are required for each splice.

NOTE: To make hand insertion of the barbed connectors into the nylon easier, the tube end must be soaked in a cup of boiling water for one minute immediately before pushing the barbs into the nylon. The 5/16-inch barbed connector is used for splicing 5/16-inch tubing.

5. Install the barbed connectors into each end of the replacement tubing using boiling water as outlined.
6. Install the clips onto any tubes which might be difficult to access once the final splices are completed.
7. Complete the splice of the replacement nylon to the original nylon tubing at both ends. (Use the boiling water method mentioned previously, to get the required number of barbs engaged.)
8. Install any remaining clips which were removed for this service and check that the tubes are secure in the original clips.
9. Start engine and check for leaks.

REPLACING DAMAGED PUSH CONNECTORS

1. Relieve fuel system pressure. If necessary, refer to the procedure in this section.

NOTE: Damaged push connectors must be discarded and replaced with new push connectors. If only the retaining clip is damaged, replace the clip.

2. Disconnect the damaged push connector. Be sure to bend the shipping tab to the side before removing retaining clip.
3. Select the proper size replacement push connector and nylon tube assembly.
4. Cut out a section of the original nylon tube to the same length as the nylon tube attached to the new push connector.
5. Install proper barbed connector into the replacement nylon assembly.

NOTE: To make hand insertion of the barbed connectors into the nylon easier, the tube end must be soaked in a cup of boiling water for one minute immediately before pushing the barbs into the nylon. The 5/16-inch barbed connector is used for splicing 5/16-inch tubing.

6. Complete the splice by connecting the barbed connector to the original nylon.
7. Connect the new connector assembly to the steel tube end.
8. Check that the underbody clips are properly securing the fuel tubes.
9. Start engine and check for leaks.

GENERAL SERVICE PROCEDURES

REPLACING DAMAGED STEEL PUSH-CONNECT TYPE ENDS

1. Relieve fuel system pressure. If necessary, refer to the procedure in this section.
2. Using a tube cutter, remove the damaged push-connect tube end at a convenient distance from the end.

NOTE: Allow for adequate room to tighten a union with a wrench at this location.

3. Choose a proper replacement push-connect tube end.
4. If required, form the new tube end to the same shape as the damaged tube end which was removed.
5. Select the proper size union and attach the new steel tube end to the original tube.
6. Clean off the steel tube end and replace the push connector onto the tube. (A new retainer clip is recommended.)
7. Check that the underbody clips are properly securing the fuel tubes.
8. Start engine and check for leaks.

SECTION 24-51 FUEL FILTERS

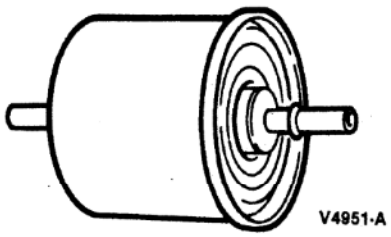
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High-Pressure Fuel Pump Filter 4
Fuel-Injector Filter 5

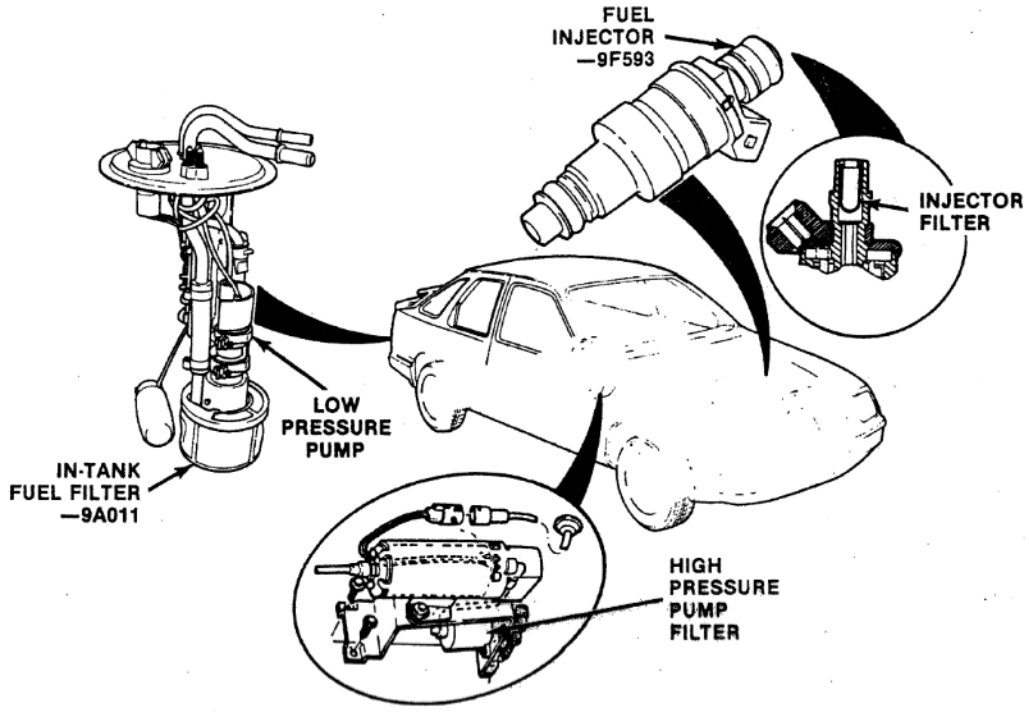

V4951-A

DESCRIPTION

The fuel handling components in the electronic fuel-injection system are protected by six fuel filters. A nylon filter element is attached to the fuel pickup tube inside the fuel tank to protect the low-pressure pump from fuel tank contaminants. The fuel filter, fuel level sending unit, and low-pressure fuel pump are installed through the top of the tank as a single assembly.

The next filter is mounted on the high-pressure pump mounting bracket, which is located under the body on the left-rear body frame rail. The in-tank filter and high-pressure pump filters are serviceable.

The remaining four filters are located at the fuel-inlet port on each of the fuel injectors. These filters are not serviceable. If an injector filter becomes clogged, the fuel-injector assembly must be replaced.



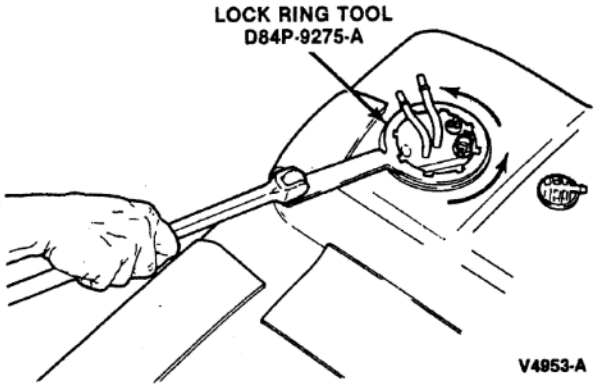
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REMOVAL AND INSTALLATION

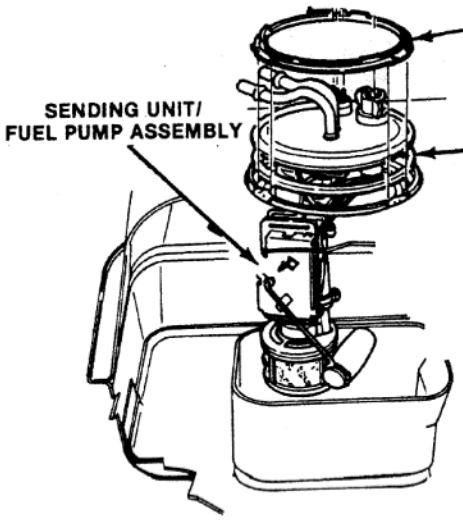
IN-TANK FUEL FILTER

Removal

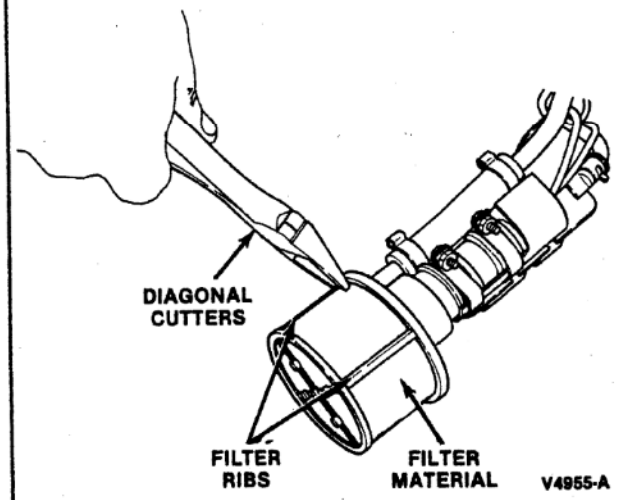
1. Remove the fuel tank. If necessary, refer to Section 24-50.
2. Remove the sending unit/fuel pump lock ring, using Lock Ring Tool D84P-9275-A, or equivalent. Turn the lock ring counterclockwise to release from the tank.



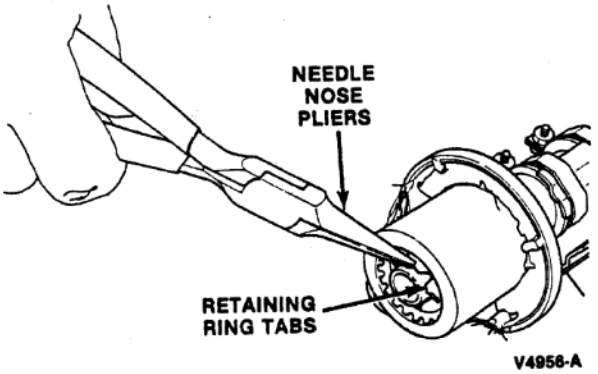
3. Remove the lock ring, seal ring, and sending unit/fuel pump from the fuel tank.



4. Using a pair of diagonal cutters, snip the four filter ribs, cut the filter material, and remove the bottom of the filter.



5. Pry up the retaining ring tabs and remove the filter.



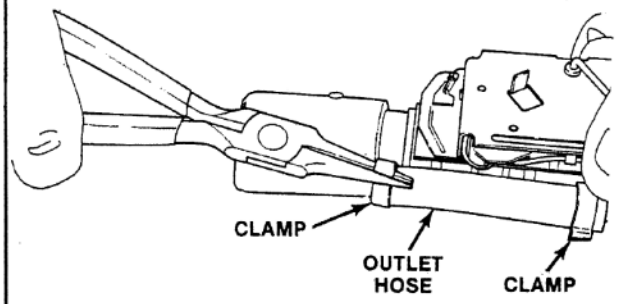
REMOVAL AND INSTALLATION

IN-TANK FUEL FILTER

Removal (Continued)

NOTE: Each time the electric fuel pump is removed from the fuel tank, the rubber hoses and clamps must be replaced (in addition to the gasket). When the rubber hoses become exposed to the air outside the tank, the air reacts with the fuel-soaked rubber, eventually causing the hose to become brittle, even if the hose is returned to the tank. This deterioration seriously weakens the hose and will lead to premature failure of the hose.

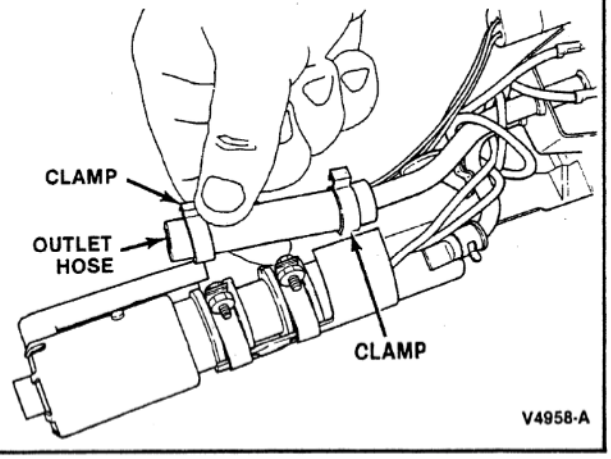
6. Cut and remove the outlet hose clamps.



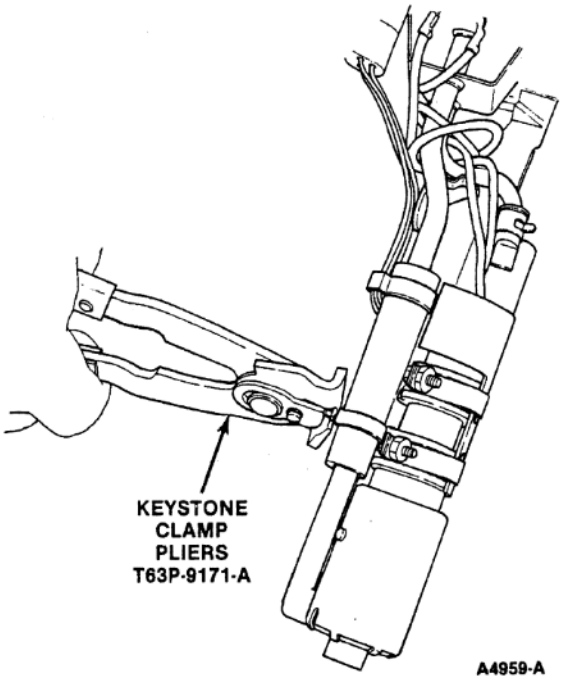
7. Remove and discard the outlet hose.

Installation

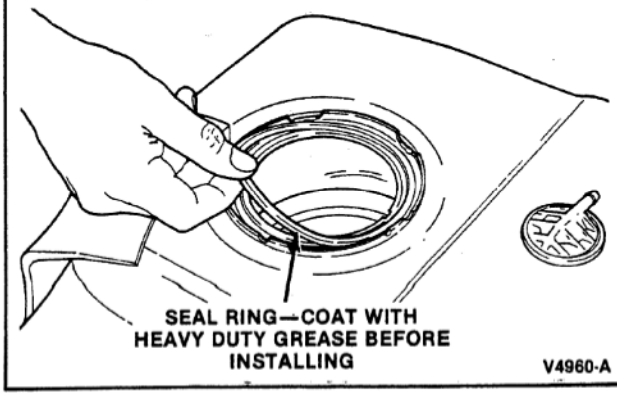
1. Install two new keystone clamps on the replacement outlet hose and install the hose.



2. Crimp the outlet hose clamps using Keystone Clamp Pliers T63P-9171-A, or equivalent.



3. Push the new filter on the pump pickup tube. The retaining ring will lock it in position.
4. Clean the fuel tank seal ring groove.
5. Put a light coating of C1AZ-19590-B, or equivalent heavy-duty grease on a new seal ring to prevent the lock ring from dragging on the seal during installation.
6. Position the new seal ring in the fuel tank groove.



REMOVAL AND INSTALLATION

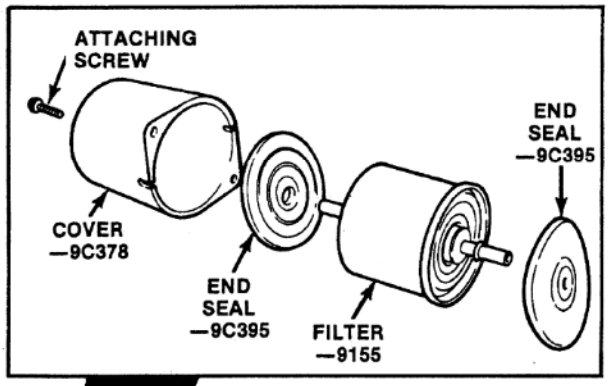
IN-TANK FUEL FILTER

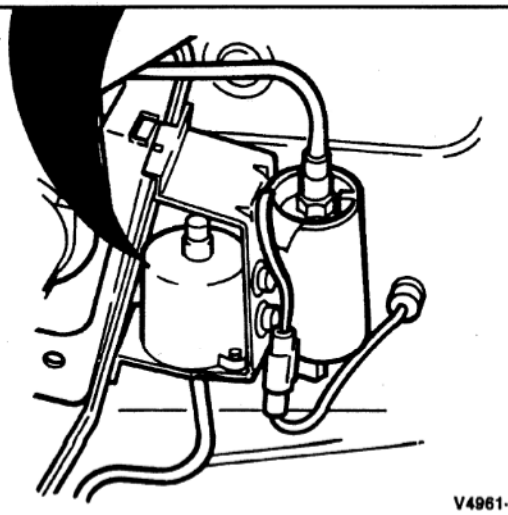
Installation (Continued)

7. Position the sending unit/fuel pump in the fuel tank.
8. Hold the assembly in position and install the lock ring fingertight. Make sure that all locking tabs are under the tank lock ring tabs.
9. Tighten the lock ring, using Lock Ring Tool D84P-9275-A, or equivalent.
10. Install the fuel tank. If necessary, refer to Section 24-50.

HIGH-PRESSURE FUEL PUMP FILTER

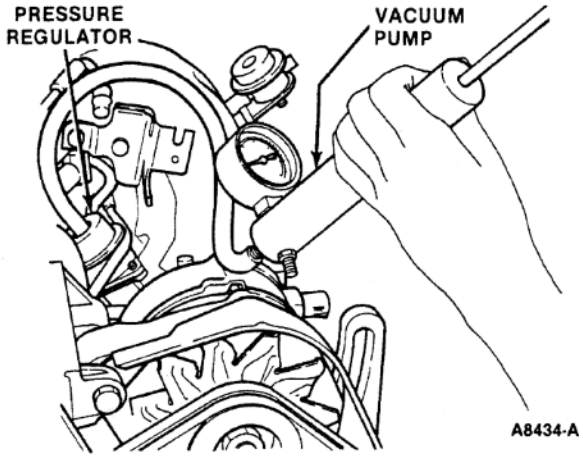
Removal





1. Depressurize the EFI fuel system using a hand-operated vacuum pump. Connect the pump hose to the fuel system pressure regulator and apply at least 25″ of vacuum.

NOTE: It takes at least three minutes for the system to depressurize. If necessary, refer to the Fuel System Pressure Relief Procedure in Section 24-50.



CAUTION: Fuel supply lines will remain pressurized for some period of time after the engine is shut off. System pressure must be relieved before disconnecting any fuel lines.

2. Raise the vehicle.
3. Disconnect the fuel lines at the filter inlet and outlet connections.

WARNING: Use care to prevent combustion from fuel spillage.

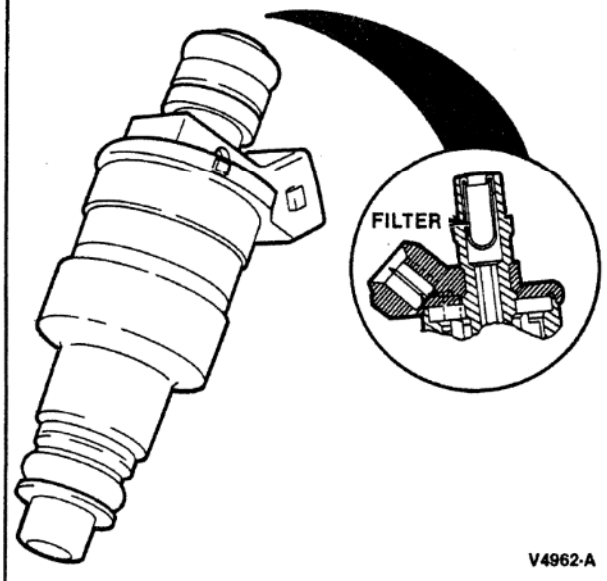
4. Remove the filter cover attaching screws and the filter.
5. Remove the filter and end seals from the filter cover.

Installation

1. Position the end seals on the filter and install the filter in the cover.
2. Position the cover on the pump mounting bracket and install the attaching screws.
3. Connect the fuel lines.
4. Lower the vehicle, start the engine, and check for leaks at the filter.

REMOVAL AND INSTALLATION

FUEL-INJECTOR FILTER



The fuel-injector filter is not serviced separately. If the filter becomes clogged, the fuel injector must be replaced.

SECTION 24-60 THROTTLE LINKAGE

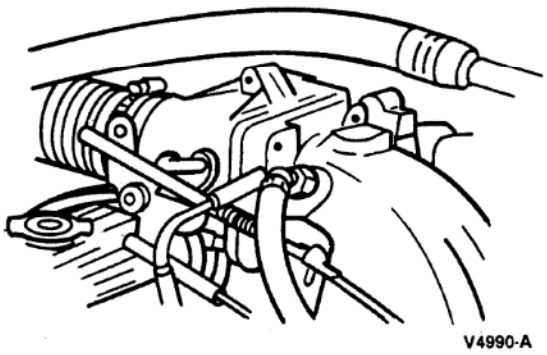
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DESCRIPTION 1

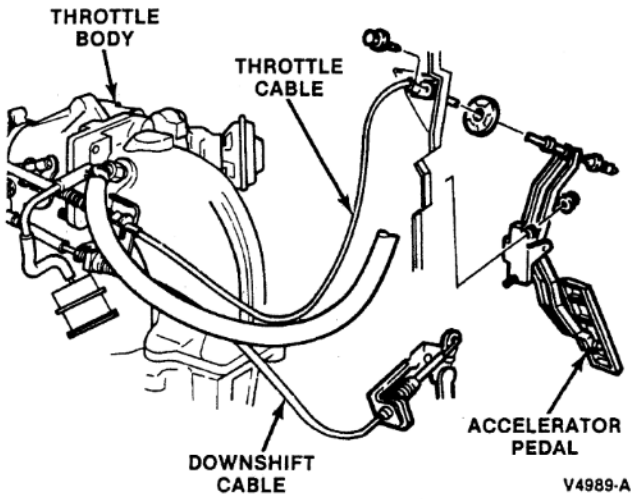
REMOVAL AND INSTALLATION

Throttle Cable 2
Accelerator Pedal Assembly 3


V4990-A

DESCRIPTION

The accelerator pedal is linked to the throttle lever through a flexible cable. The actual cable is sheathed in a protective outer casing. It is this casing that is attached to the cable routing bracket at the intake manifold and to the dash panel where the cable enters the engine compartment. The cable is attached to the throttle lever by a ball and socket arrangement with the socket located in the cable end fitting. The opposite end of the cable slips through a slot cut into the pedal lever. A plastic retainer prevents the cable from slipping out of the pedal. The accelerator pedal bracket is mounted on the dash panel with a pivot pin attaching the pedal and lever to the bracket. The throttle return spring is installed on the throttle lever end of the cable. A cushion spring is installed at the other end of the cable behind the pedal lever.



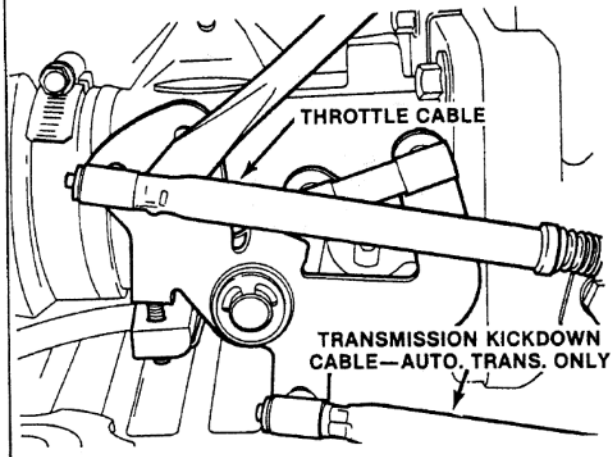
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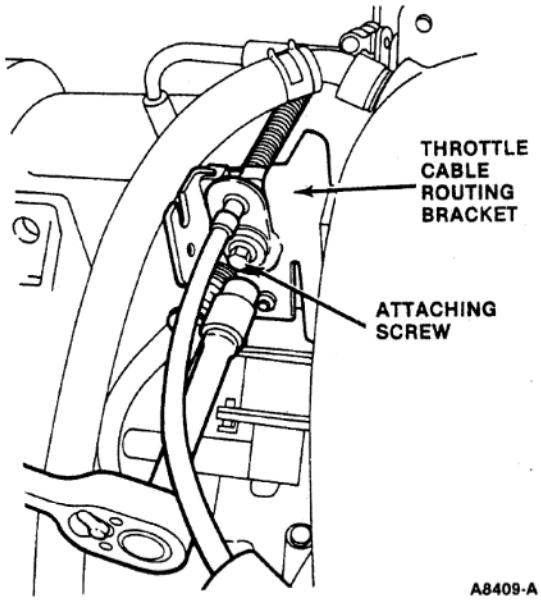
REMOVAL AND INSTALLATION

THROTTLE CABLE

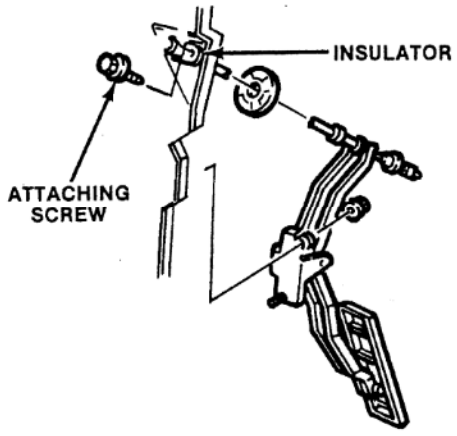
Removal

1. Disconnect the throttle cable from the throttle body lever and remove the screw attaching the cable to the routing bracket.

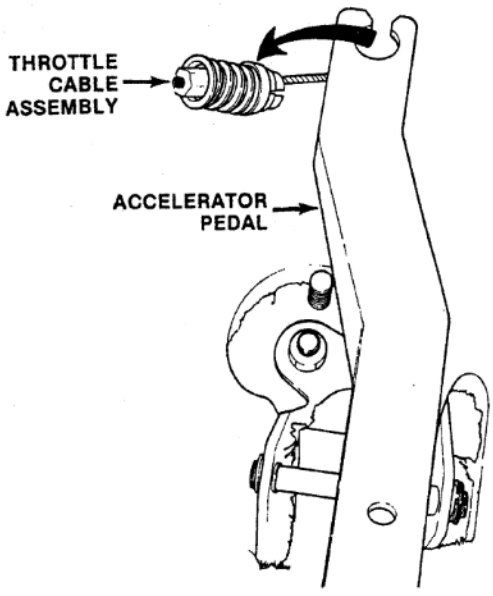




2. Remove the screw attaching the cable insulator assembly to the dash panel.



3. Remove the sound-deadening panel located under the instrument panel.
4. Disengage the cable assembly from the accelerator pedal by pulling it away from the pedal and lifting the cable through the slot in the top of the pedal.



5. Remove the cable assembly from the vehicle.

REMOVAL AND INSTALLATION

THROTTLE CABLE

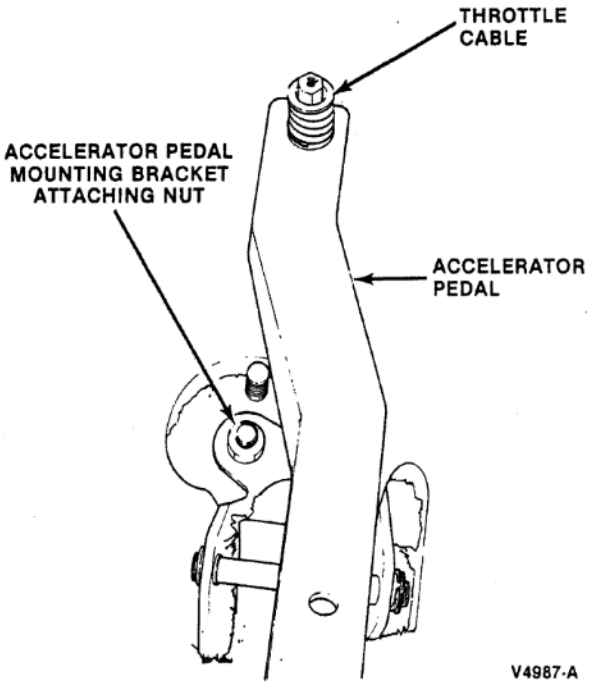
Installation

1. Slide the cable assembly through the dash panel hole.
2. Install the cable insulator assembly in the dash panel hole. Install the attaching screw.
3. Install the cable assembly in the top of the accelerator pedal.
4. Install the sound-deadening panel.
5. Place the cable assembly in the routing bracket and install the attaching screw.
6. Connect the cable assembly to the throttle body lever.

ACCELERATOR PEDAL ASSEMBLY

Removal

1. Remove the pedal mounting bracket attaching nut in the engine compartment.
2. Remove the sound-deadening panel located under the instrument panel.
3. Disengage the throttle cable assembly from the accelerator pedal by pulling it away from the pedal and lifting the cable through the slot in the top of the pedal.



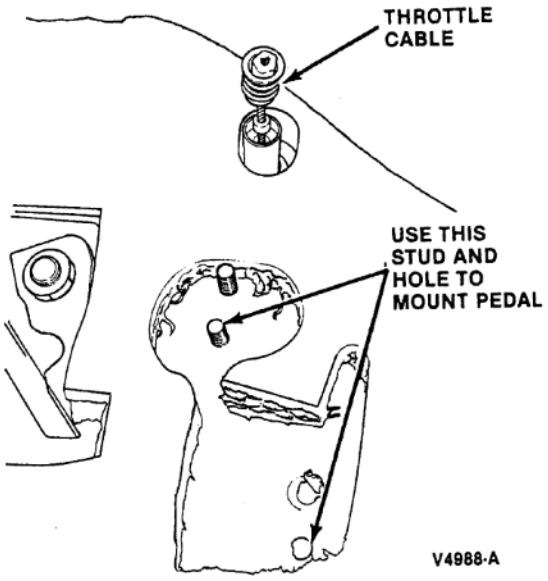
4. Remove the pedal mounting bracket attaching nut inside the passenger compartment.
5. Remove the pedal assembly.

REMOVAL AND INSTALLATION

ACCELERATOR PEDAL ASSEMBLY

Installation

1. Install the pedal assembly.



2. Install the pedal bracket attaching nut inside the passenger compartment.

3. Install the throttle cable assembly in the top of the accelerator pedal.

4. Install the sound-deadening panel.

5. Install the pedal bracket attaching nut inside the engine compartment.

GROUP 24 SPECIFICATIONS

FUEL SYSTEM DESIGN:

- Electronic Fuel Injection (EFI), multipoint, four injectors
- Two electric fuel pumps: Low pressure—in tank
  High pressure—on rear frame rail
- Three fuel filter locations: In-tank
  High pressure pump outlet
  Each fuel injector
- Air filter: Replaceable, dry paper element
- Fuel line: nylon and steel

TURBOCHARGER DESIGN:

- Blow through system
- Amount of boost: 15 psi
- Boost control: Pressure actuated wastegate, opening and closing regulated by ECA controlled boost solenoid
- Engine oil used to lubricate bearings
- Engine coolant used to cool bearings
- Overboost warning buzzer, pressure switch actuated
- Boost gauge in instrument cluster

FUEL TANK CAPACITY: 57 liters/15 gallons

SERVICE SPECIFICATIONS

- Fuel system operating pressure—241-310 kPa (35-45 psi)
- Fuel system volume—7.5 ounces in ten seconds
- Turbocharger axial clearance—0.025 mm (0.001 in.) to 0.076 mm (0.003 in.)
- Turbocharger radial clearance—0.076 mm (0.003 in.) to 0.152 mm (0.006 in.)

TORQUE SPECIFICATIONS

Item	N·m	Lb-Ft
Throttle body to manifold	16-20	12-15
Upper intake manifold to lower manifold	20-30	15-22
EGR flange to intake manifold	18-26	13-19
Lower intake manifold to head	16-20	12-15
Fuel manifold to intake manifold	20-30	15-22
Fuel tank strap to body	28-40	21-30
Turbo support bracket to block	38-54	28-40
Turbo to manifold studs	38-54	28-40
Converter inlet pipe to turbo	34-47	25-35

EXHAUST SYSTEM

GROUP 26 (5000)

TITLE SECTION PAGE NO.

EXHAUST SYSTEM DIAGNOSIS 26-01

GENERAL INFORMATION 1

DIAGNOSIS

Inspection Chart—Exhaust Leakage or Noise 2
Inspection Chart—Exhaust Rattle or Vibration 3
Inspection Chart—Restricted Exhaust 4

EXHAUST SYSTEM 26-02

DESCRIPTION 1

REMOVAL AND INSTALLATION

Catalytic Converter 3
Muffler/Silencer Element 4
Inlet Pipe 5

GROUP 26

SPECIFICATIONS 1

SECTION 26-01 EXHAUST SYSTEM DIAGNOSIS

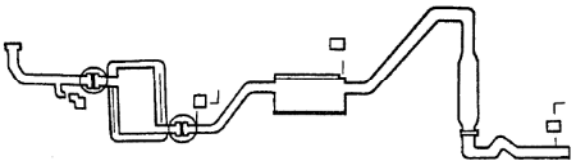
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GENERAL INFORMATION 1

DIAGNOSIS

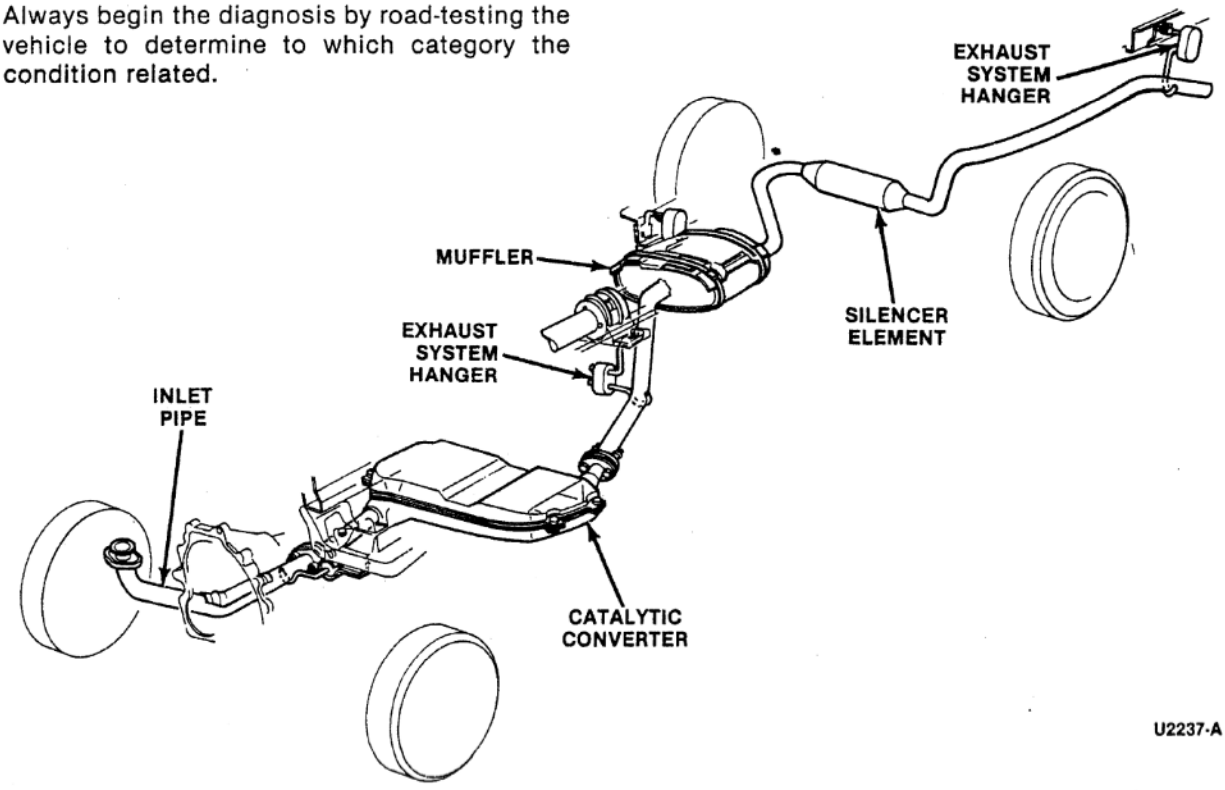
Inspection Chart — Exhaust Leakage or Noise 2
Inspection Chart — Exhaust Rattle or Vibration 3
Inspection Chart — Restricted Exhaust 4



GENERAL INFORMATION

Exhaust system malfunctions generally appear in three categories: rattle and vibrations, leakage or noise, and a restricted system.

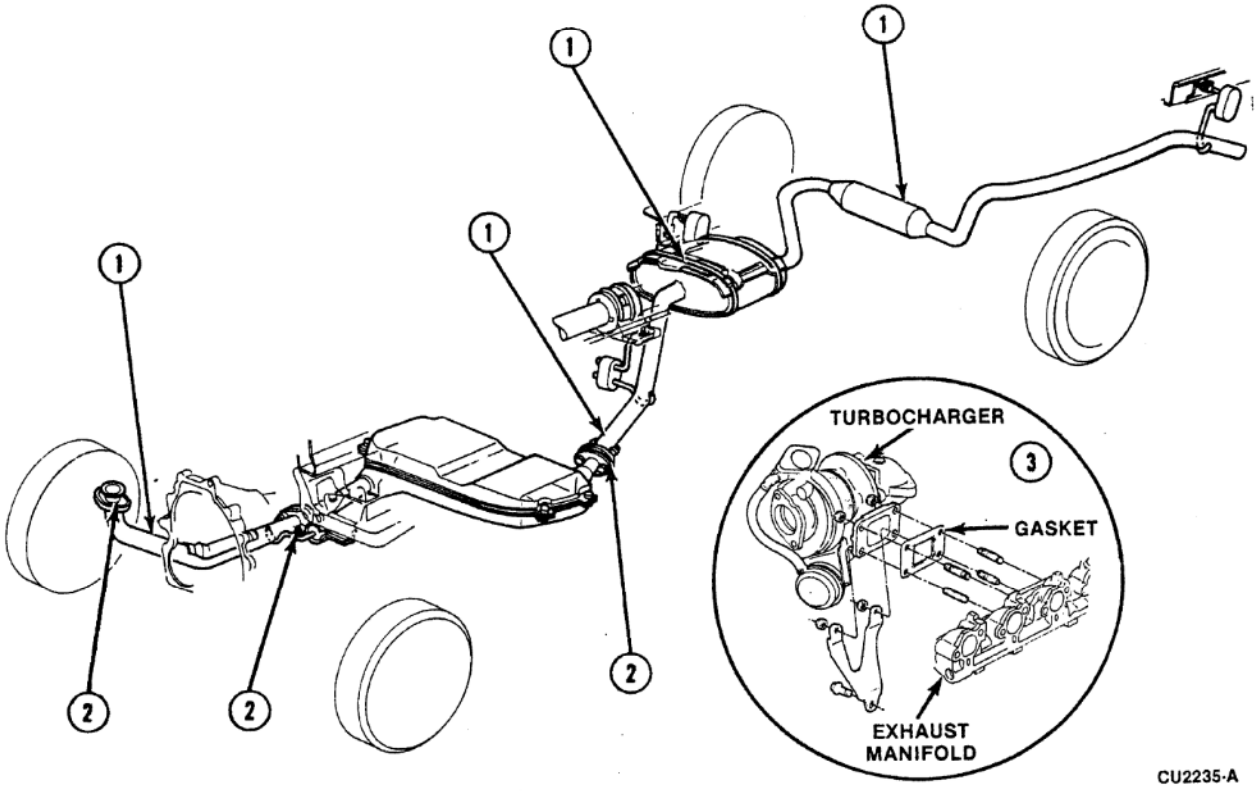
Always begin the diagnosis by road-testing the vehicle to determine to which category the condition related.



DIAGNOSIS

INSPECTION CHART — EXHAUST LEAKAGE OR NOISE

When checking for exhaust leakage or noise, inspect the entire system for burnout holes. Inspect all connections for rust holes or black exhaust soot on the body which would indicate leakage at that point. On small leaks, have an assistant hold rags over the tailpipe outlet while listening for the leak. This helps to magnify the leak.

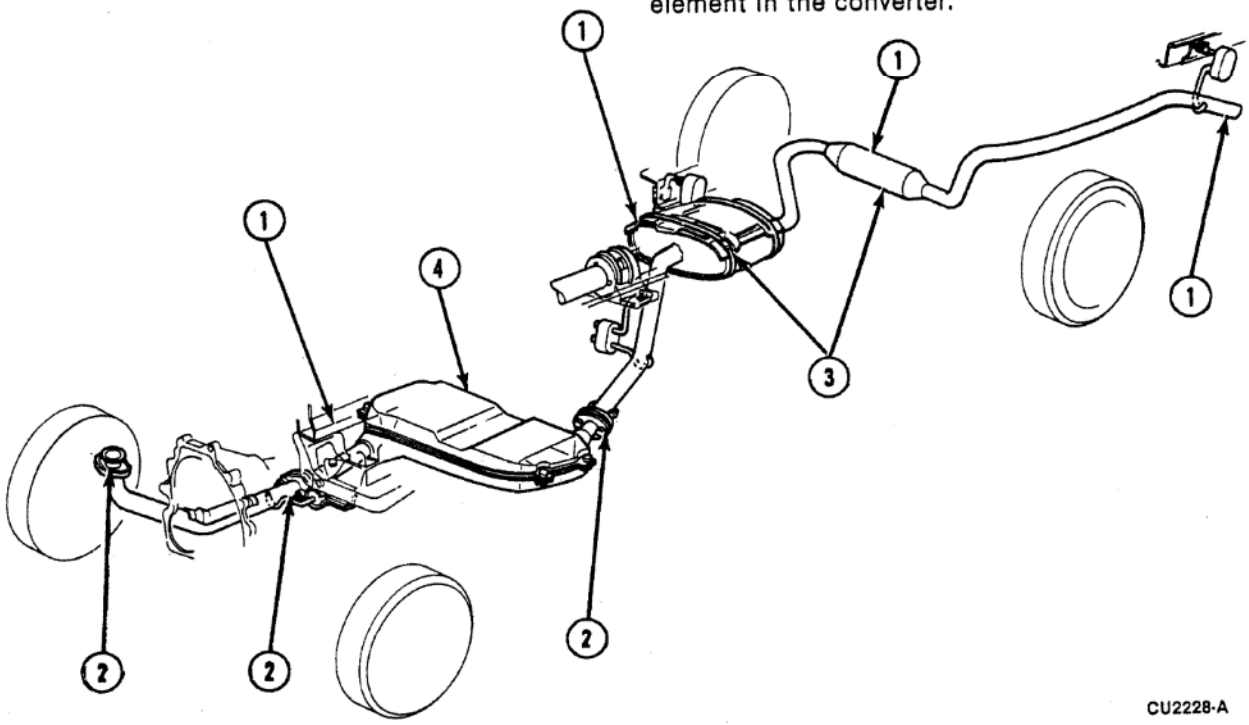


POSSIBLE CAUSE	CORRECTIVE ACTION
(1) Leaking pipes or components	Replace damaged components
(2) Loose connections	Realign and tighten connections
Leaking flange gaskets	Replace gaskets
(3) Leaking exhaust manifold or turbocharger gasket	Tighten loose connections or replace leaking gasket

DIAGNOSIS

INSPECTION CHART — EXHAUST RATTLE OR VIBRATION

When testing for a rattle or vibration condition, it is helpful to use a rubber mallet and tap on the exhaust components, to simulate the bouncing action of the exhaust, while watching for exhaust-to-body/chassis contact. Also look for loose or rusted connections and clamps and loose or broken hangers. Lightly tapping on the muffler, silencer and catalytic converter can determine if there are loose or broken baffles in the muffler or silencer or a loose or broken element in the converter.



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POSSIBLE CAUSE	CORRECTIVE ACTION
(1) Exhaust components rubbing on vehicle chassis body	Realign exhaust components Replace if damaged
(2) Loose exhaust clamps	Realign exhaust and tighten clamps
(2) Loose connections due to corrosion damage	Replace affected components
(3) Loose or broken muffler or silencer baffles	Replace muffler or silencer
(4) Loose or broken element in catalytic converter	Replace converter* and check engine to determine cause of converter malfunction, i.e., engine misfire, overrich fuel mixture.

*When replacing the catalytic converter because of broken element, always inspect the muffler for particles which could restrict the exhaust system or cause a rattle.

DIAGNOSIS

INSPECTION CHART — RESTRICTED EXHAUST

RESTRICTED EXHAUST SYSTEM

A restricted exhaust system will be indicated by a large loss of engine power, poor fuel economy and backfiring. Before condemning the exhaust system, always check the engine and related systems for proper operation.

There is no easy method to finding a restricted exhaust component. By following a systematic approach, considerable time and effort can be saved.

Test 1

1. Connect vacuum gauge to engine manifold vacuum.
2. Start engine and observe vacuum gauge. Vacuum should be between 16 to 21 in. Hg.
3. Raise engine speed to 2,000 rpm. Vacuum should decrease then increase and settle at 16 to 21 in. Hg.

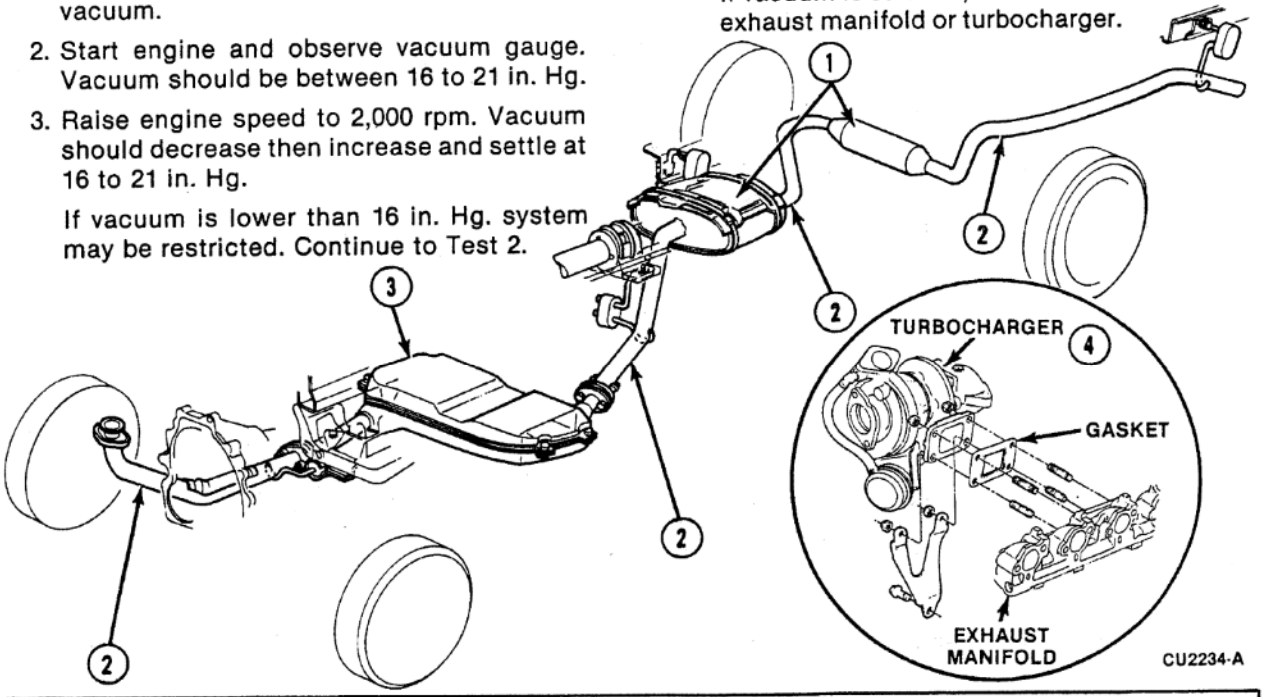
   If vacuum is lower than 16 in. Hg. system may be restricted. Continue to Test 2.

Test 2

1. Disconnect the exhaust component farthest from the engine, i.e., muffler and silencer.
2. Repeat Test 1. If vacuum is between 16 and 21 in. Hg, muffler, silencer, or tailpipe is not restricted. If vacuum is still low, continue to Test 3.

Test 3

1. Disconnect the catalytic converter.
2. Repeat Test 1. If vacuum is between 16 and 21 in. Hg, converter or inlet pipe is not restricted. If vacuum is still low, the restriction is in the exhaust manifold or turbocharger.



POSSIBLE CAUSE	CORRECTIVE ACTION
(1) Restricted muffler or silencer	Replace muffler or silencer
(2) Bent or kinked exhaust pipes	Straighten or replace bent exhaust pipes
(3) Restricted catalytic converter	Replace converter and determine cause of malfunction, i.e., engine misfire, overrich fuel mixture
(4) Restricted exhaust manifold or turbocharger ports	Remove exhaust manifold or turbocharger and attempt to clear blockage. If blockage cannot be cleared, replace defective component.

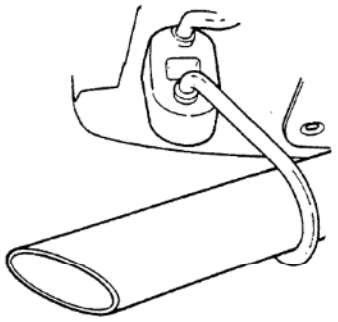
SECTION 26-02 EXHAUST SYSTEM

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DESCRIPTION 1

REMOVAL AND INSTALLATION
Catalytic Converter 3
Muffler/Silencer Element 4
Inlet Pipe 5



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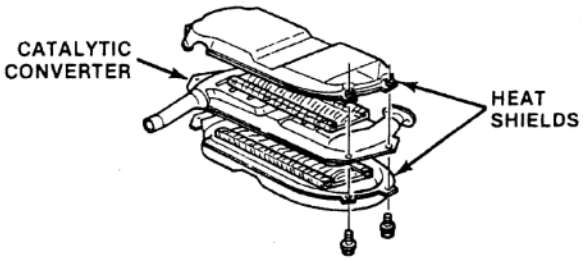
DESCRIPTION

The exhaust system consists of an inlet pipe, catalytic converter and muffler assembly. The muffler assembly consists of a muffler and silencer element. The silencer is mounted laterally to the body and is located near the rear axle. The converter outlet pipe, muffler, silencer and tailpipe are welded to form a single assembly. The catalytic converter is connected to the muffler and inlet pipe with a flexible flange joint at each end. The joints are held together by bolts, tab nuts and bolt springs. Leaks between the joints are prevented by cone shaped, graphite impregnated gaskets. The entire assembly is connected to the turbocharger by another flanged connection at the front of the inlet pipe.

The exhaust system is suspended under the vehicle body at four points and the turbocharger outlet flange. At these points hangers are bolted or welded to the underbody or transmission crossmember and exhaust system components. Rubber mounts are installed between the body and component hangers to isolate the exhaust system from the body.

The catalytic converter is an emission control device added to the exhaust system to chemically alter elements contained in the exhaust gases. The catalytic converter contains a ceramic honeycomb that is coated with a rhodium/platinum catalyst. These chemicals will react with oxides of nitrogen (NO_X), unburned hydrocarbons (HC), carbon monoxide (CO), to form nitrogen (N_2), water vapor (H_2O), and carbon dioxide (CO_2). Because this catalytic converter is able to chemically alter these three elements, it is referred to as a TWC, or three-way catalyst.

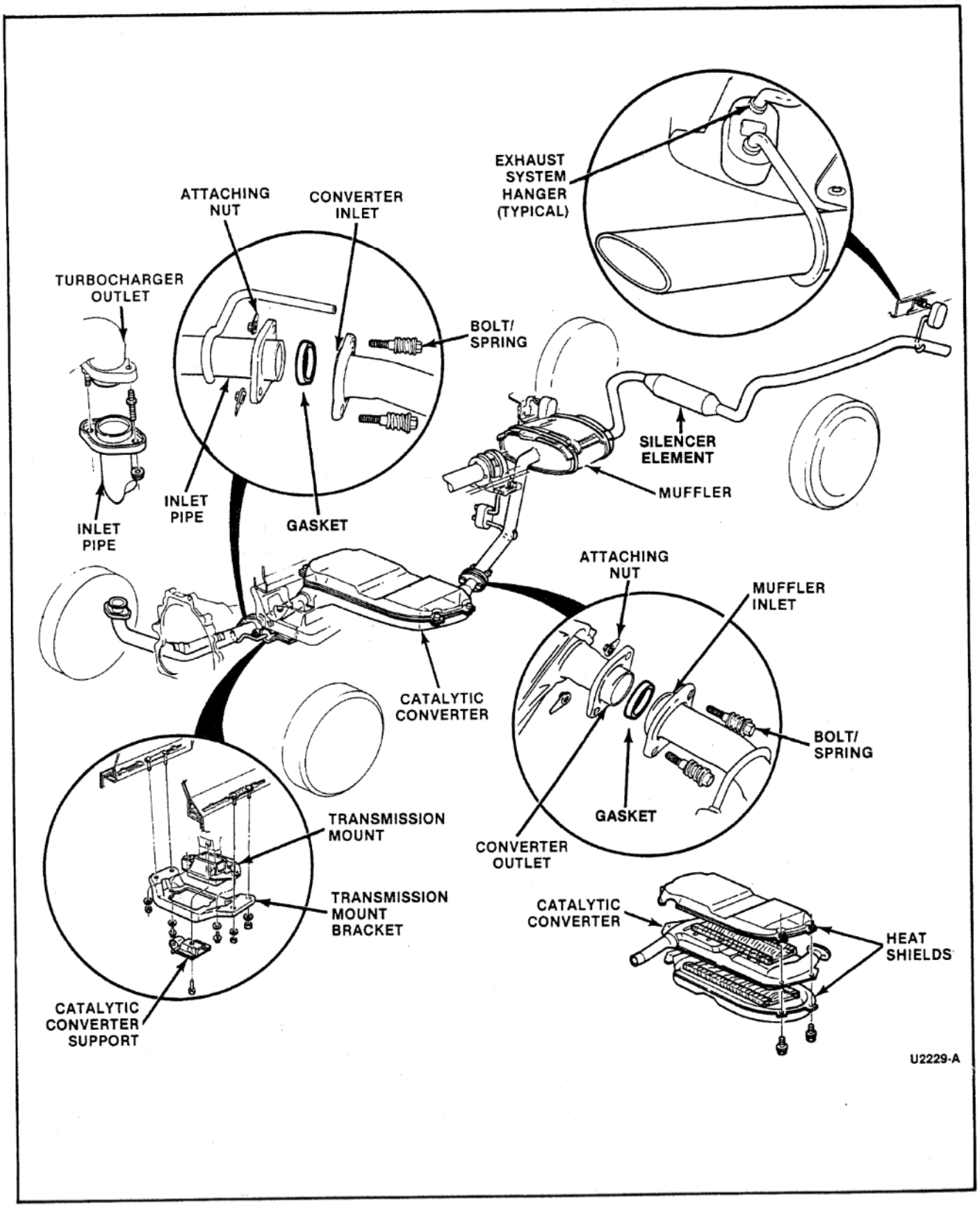
During this chemical process the catalytic converter produces additional heat. To direct this heat away from the body, the catalytic converter has an upper heat shield and a lower grass screen. An aluminum foil insulator is installed between the shield and screen to cut down on the transfer of heat and noise into the underbody of the vehicle. If the vehicle is equipped with an automatic transmission, an additional heat shield is installed to prevent transfer of heat to the transmission.



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CAUTION: The normal operating temperature of the exhaust system is very high. Never work around or attempt to service any part of the exhaust system until it has cooled. Use special care when working around the catalytic converter. These units heat to a high temperature after only a short period of engine operation.

DESCRIPTION



REMOVAL AND INSTALLATION

CATALYTIC CONVERTER

Removal

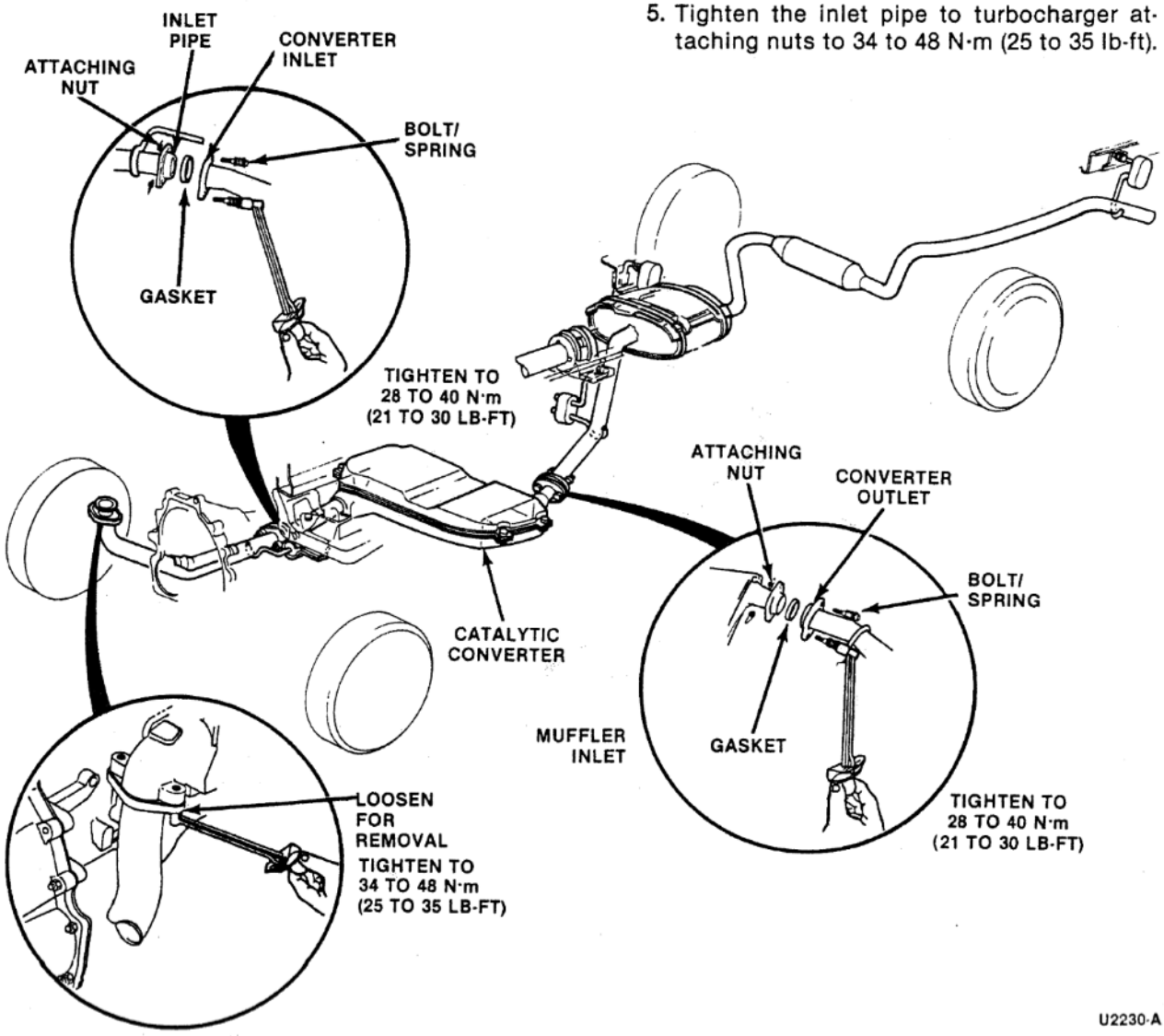
1. Remove the bolts, springs and nuts attaching the catalytic converter to the muffler inlet flange.

   If necesssary, support the catalytic converter with a suitable stand.
2. Remove the bolts, springs and nuts attaching the catalytic converter to the inlet pipe.
3. Remove the catalytic converter.
4. Loosen the inlet pipe attaching nuts at the turbocharger outlet flange.

Installation

1. Inspect the inlet and outlet pipe gaskets and replace if damaged.
2. Position the catalytic converter in the vehicle and install the bolts, springs and nuts attaching the catalytic converter to the inlet pipe.

   Do not tighten the attaching nuts.
3. Position the catalytic converter against the muffler inlet flange and install the attaching bolts, springs and nuts.
4. Tighten the inlet pipe and muffler attaching bolts to 28 to 40 N·m (21 to 30 lb-ft).
5. Tighten the inlet pipe to turbocharger attaching nuts to 34 to 48 N·m (25 to 35 lb-ft).



REMOVAL AND INSTALLATION

MUFFLER/SILENCER ELEMENT

Removal

1. Remove the bolts, springs and nuts attaching the catalytic converter to the muffler inlet flange.
2. Support the muffler on a suitable stand.
3. Disengage the muffler assembly hangers from the three rubber mounts.

   Disengage the mounts in the following order: rear, front, middle.

NOTE: Spray the hangers and mounts with silicone lubricant to ease removal.

4. Remove the muffler/silencer element assembly through the rear of the vehicle.

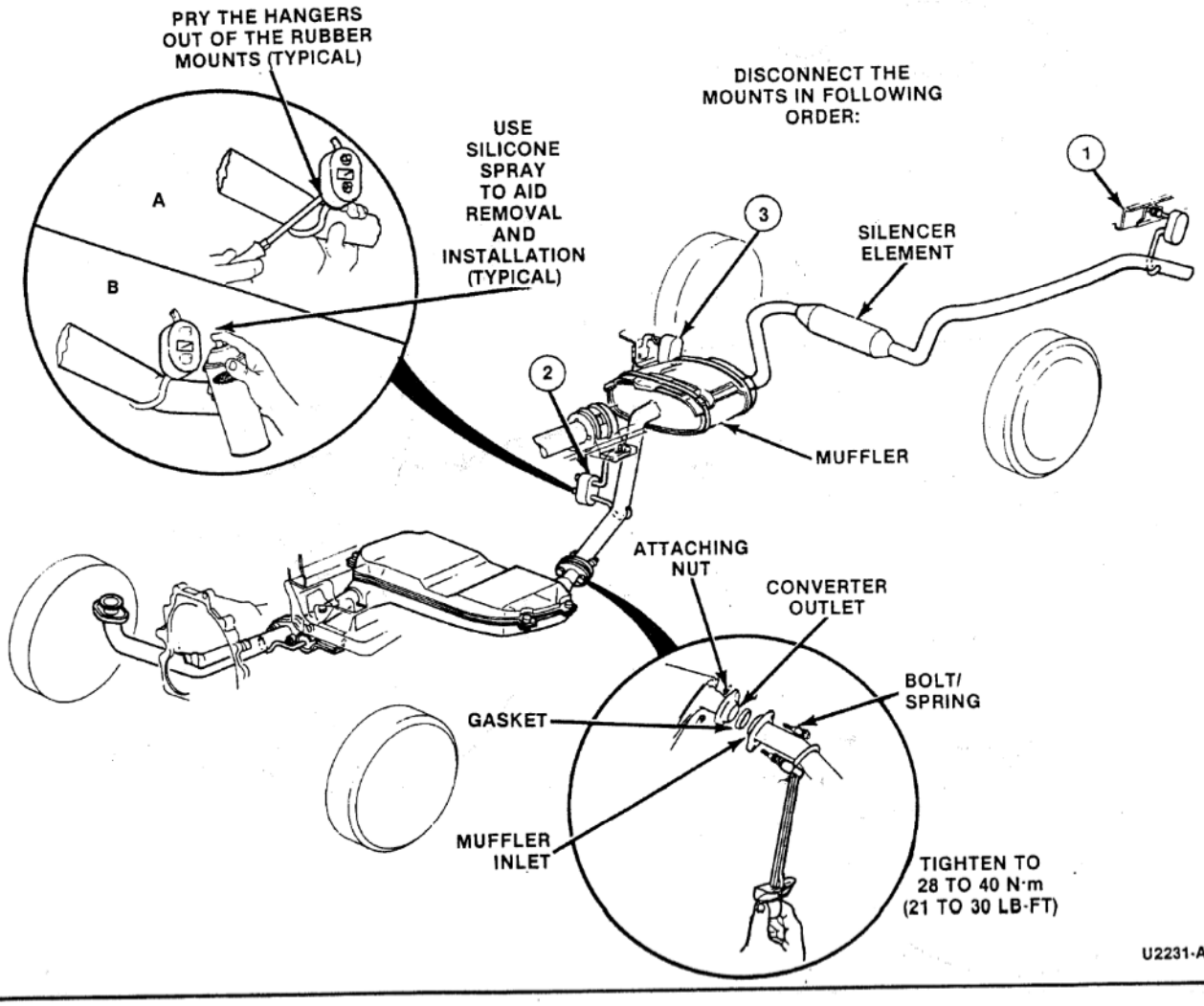
Installation

1. Position the muffler/silencer assembly in the vehicle. Support the muffler on a suitable stand.
2. Engage the muffler and assembly hangers in the rubber mounts.

   Engage the mounts in the following order: middle, front, rear.

3. Install the catalytic converter-to-muffler inlet flange attaching bolts, springs and nuts.

   Tighten the attaching bolts to 28 to 40 N·m (25 to 35 lb-ft).



REMOVAL AND INSTALLATION

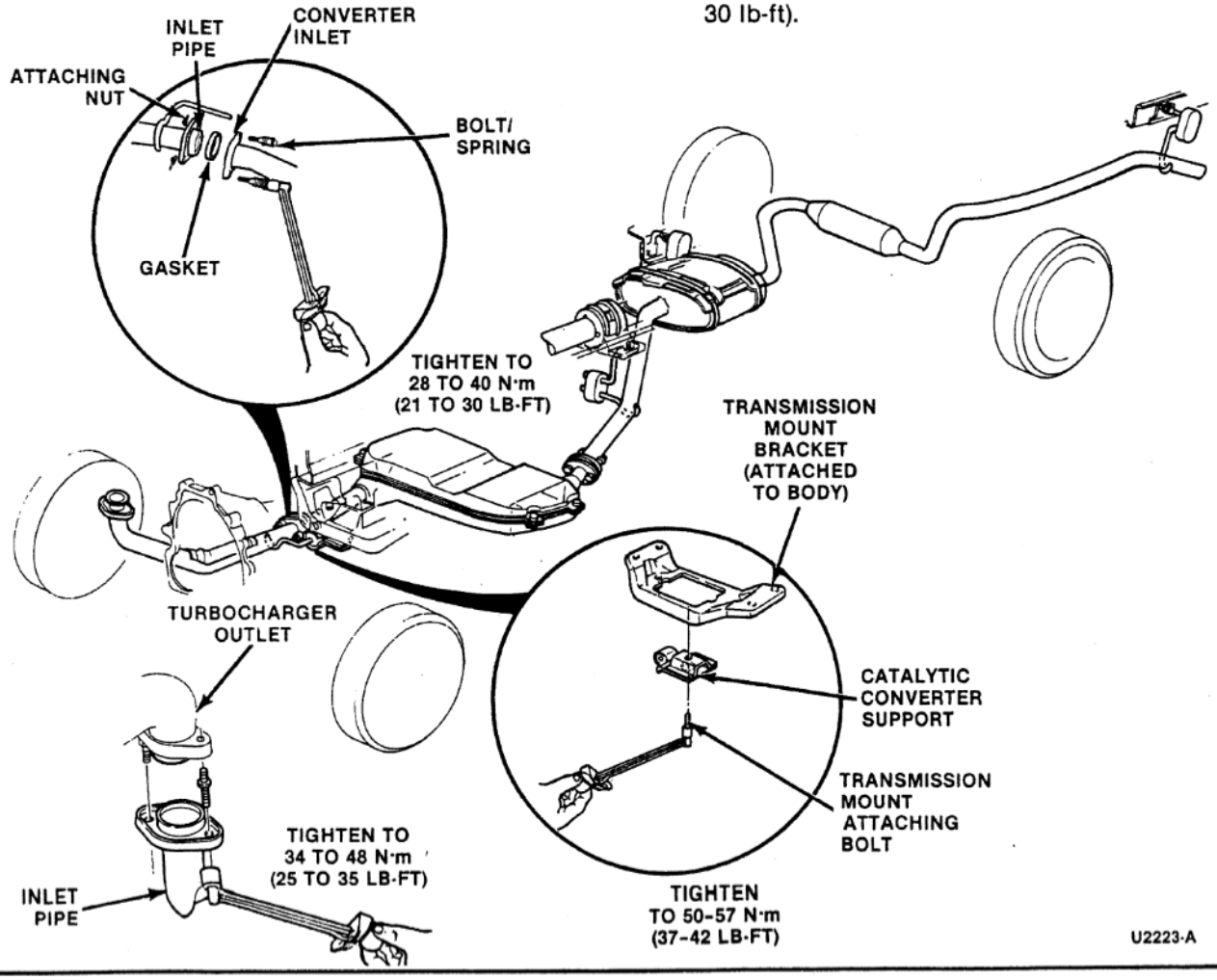
INLET PIPE

Removal

1. Remove the bolt attaching the exhaust system hanger bracket to the transmission rear mount and crossmember.
2. Remove the hanger bracket and install the transmission mount attaching bolt. Do not tighten the bolt.
3. Support the front of the catalytic converter with a piece of wire connected to a convenient underbody component.
4. Remove the bolts, springs and nuts attaching the catalytic converter to the inlet pipe.
5. Remove the nuts attaching the inlet pipe to the turbocharger outlet flange and remove the inlet pipe.

Installation

1. Inspect the inlet pipe-to-converter gasket and replace, if necessary.
2. Position the inlet pipe and install the turbocharger flange attaching nuts. Install the attaching nuts finger tight.
3. Remove the transmission mount attaching bolt, install the exhaust hanger and install the mount bolt.
4. Install the bolts, springs and nuts attaching the catalytic converter to the inlet pipe.
5. Tighten the transmission mount bolt to 50 to 57 N·m (37 to 42 lb-ft).
6. Tighten the inlet pipe to turbocharger attaching nuts to 34 to 48 N·m (25 to 35 lb-ft).
7. Tighten the inlet pipe to catalytic converter attaching bolts to 28 to 40 N·m (21 to 30 lb-ft).



GROUP 26 SPECIFICATIONS

CATALYTIC CONVERTER **TYPE TWC**

(Three Way Catalyst)

TORQUE CHART

ITEM	N·m	lb-ft
Inlet Pipe to Turbocharger	34–48	25–35
Inlet Pipe to Converter Inlet	28–40	21–30
Converter Outlet to Muffler Inlet	28–40	21–30

COOLING SYSTEM

GROUP 27 (8000)

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DIAGNOSTIC PROCEDURES
- Inspection 4
- Pressure Cap Testing 4
- Cooling System Pressure Testing 5
- Thermostat Testing 6

MAINTENANCE PROCEDURES
- Coolant Level Check 6
- Coolant Condition Check 6
- Coolant Draining and Replacement 7
- Cooling System Flushing 7

DIAGNOSIS CHART—Cooling Fan 11

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ADJUSTMENTS
- Alternator Drive Belt Tension 2
- A/C Compressor Drive Belt Tension 3

REMOVAL AND INSTALLATION
- A/C Compressor Drive Belt 4
- Alternator Drive Belt 4

COOLING SYSTEM 27-03

DESCRIPTION 1
REMOVAL AND INSTALLATION
- Radiator 4
- Water Pump 7
- Thermostat 7
- Heater Valve 8
- Oil Cooler 9

REPAIRS
- Cleaning 9
- Leak Testing 10
- Leak Repair 10

ENGINE COOLING FAN 27-10

DESCRIPTION 1
REMOVAL AND INSTALLATION
- Engine Cooling Fan and Shroud Assembly 2
- Engine Cooling Fan Motor 3
- Engine Coolant Temperature Switch 3
- Engine and A/C Fan Relays 3

GROUP 27

SPECIFICATIONS 1

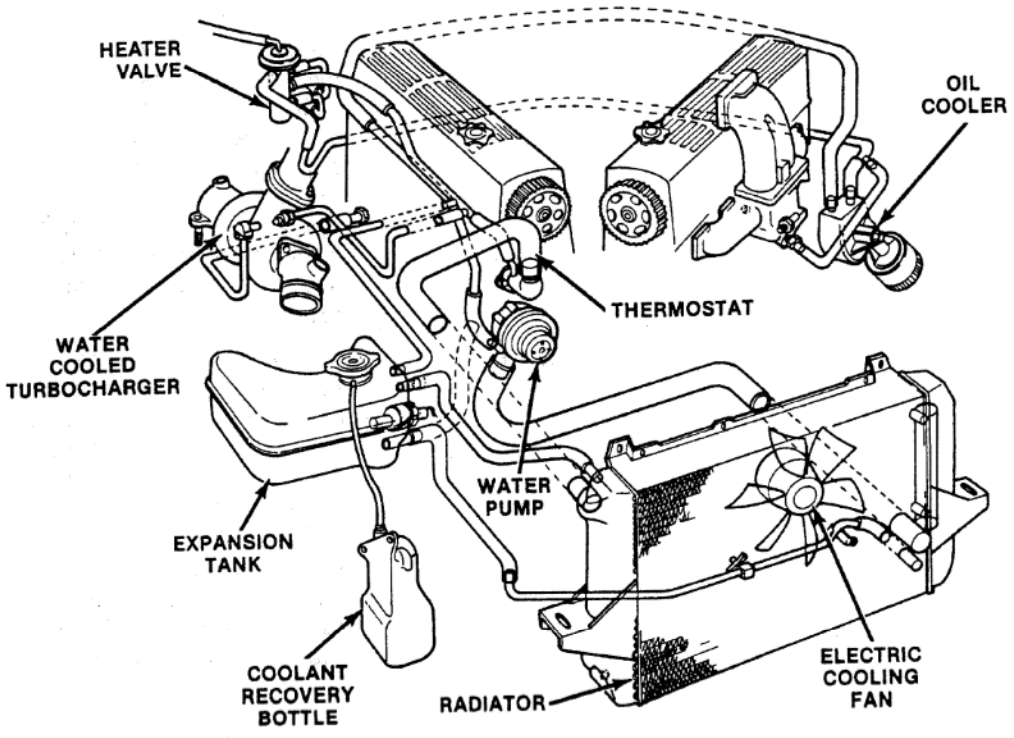
SECTION 27-01 COOLING SYSTEM—DIAGNOSIS

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Coolant Level Check	6
Coolant Condition Check	6
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Cooling System Flushing	7
DIAGNOSIS CHART—Cooling Fan	11

GENERAL INFORMATION

Symptoms of cooling system trouble fall into three categories, loss of coolant, overheating and failure to reach normal operating temperature. Because of the complexity of the XR4Ti system, a careful, systematic approach to diagnosis is essential if results are to be conclusive. The possible causes and corrections for each type of complaint are detailed in the diagnosis charts in this section.



NOTE: MANUAL TRANSMISSION VEHICLE SHOWN—AUTOMATIC TRANSMISSION SIMILAR

DIAGNOSIS CHART

COOLING SYSTEM

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
• Coolant loss	• Pressure cap not pressurizing	• Inspect cap. Wash both surfaces of rubber cap seal and sealing surfaces of vacuum valve. Inspect and clean sealing surface in expansion tank filler neck. • Pressure test cap and replace it if relief pressure is not within 2 psi of cap rating (14 to 18 psi). If necessary, refer to test procedure in this section.
	• System leakage (external).	• Pressure test system. If necessary, refer to test procedure in this section. • If system will not hold pressure, inspect all system connections for external leakage while maintaining pressure with test pump. Check all hose connections, edges of pump, thermostat housing, intake manifold and cylinder head gaskets, radiator core-to-tank joints, drain cock, core plugs, expansion tank, heater valve, and transmission oil cooler line connections, if applicable. Service or replace leaking components as required.
	• System leakage (internal)	• Check dipstick for signs of coolant in engine oil supply. • Check head bolt torque and tighten as required. If necessary, refer to Section 21-05 for torque specifications. • Disassemble engine to check for blown gaskets, warped head or block surfaces, or cracks in intake manifold, head or block castings. If necessary, refer to Section 21-05 for engine disassembly and inspection procedures. CQ2237-A1

DIAGNOSIS CHART

COOLING SYSTEM

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
• Overheating	• Low coolant level	• Fill as required. Check possible causes for coolant loss. If necessary, refer to coolant level check procedure in this section.
	• Excessive rust in coolant	• Drain and flush system and refill with new coolant. If necessary, refer to flushing and coolant replacement procedures in this section.
	• Pressure cap not pressurizing	• Pressure test cap and replace if relief pressure is not within 2 psi of cap rating. If necessary, refer to test procedure in this section.
	• Radiator or A/C condenser obstructed	• Remove debris from air passages.
	• Thermostat not opening	• Test thermostat and if not satisfactory, replace it. If necessary, refer to test procedure in this section.
	• Fan drive motor inoperative	• Test motor and control circuit and service as required. If necessary, refer to diagnosis chart in this section.
	• Ignition timing off	• Check timing and advance, and adjust as required. If necessary, refer to Section 23-01 for procedure and specifications.
	• False temp gauge reading	• Check instrument circuits and service as required.
	• Engine coolant passages obstructed	• Check head, block, intake manifold and pump for blockage and remove or flush clear. If necessary, refer to Section 21-05.
	• Exhaust system restricted	• Inspect exhaust system for damage or obstructions, and service as required. If necessary, refer to Group 26.
• Failure to reach normal operating temperature	• Thermostat not closing	• Test thermostat and replace if not satisfactory. If necessary, refer to test procedure in this section.
	• False temp gauge reading	• Check instrument circuits and service as required.

CQ2237-A2

DIAGNOSTIC PROCEDURES

INSPECTION

The first step in cooling system diagnosis is a thorough inspection of the entire system. The engine should be warmed up to normal operating temperature and pressure, evidenced by warmth and firmness of the upper radiator hose, then shut off.

WARNING: Stay clear of cooling fan, since increased coolant temperature may cause it to start at any time, even with the ignition switch OFF.

With the system under pressure, check for leaks at:

- All hose connections, radiator, water pump, thermostatic housing, expansion tank, heater bypass lines, turbocharger cooling loop connections, heater valve and core connections, oil cooler, and intake manifold hose nipple.
- Gasketed joints at water pump, thermostat housing, cylinder head, intake manifold, and radiator side tanks.
- Threaded water jacket fittings—turbocharger cooler outlet, intake manifold nipple, fan switch, control module temp sensor, temp gauge sender, and automatic transmission oil cooler fittings in radiator left-side tank, if applicable.

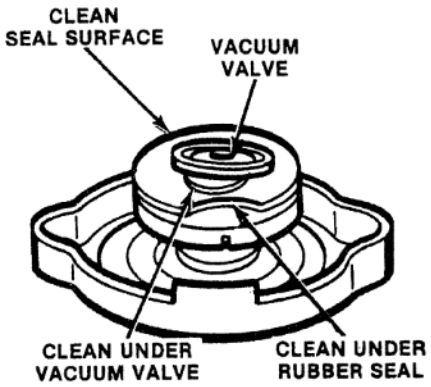
Also, check all hoses for cracks, bulges, soft spots or evidence of chafing or scorching due to improper routing. Check the dipstick for indications of coolant in the engine oil supply.

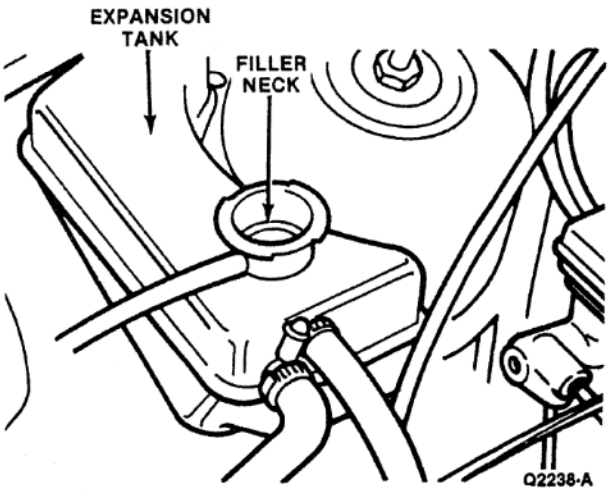
If the upper hose does not noticeably harden on warm-up, the system is not pressurizing, most likely due to faulty pressure cap sealing or a defective cap. To check the cap, the engine must be stopped and the cap removed.

WARNING: Never remove the cap while the engine is running. Doing so could result in damage to the cooling system or engine, and/or personal injury. Use extreme care when removing the cap from a hot system to avoid a blow out of scalding hot coolant or steam. If possible, wait for the engine to cool. Then wrap a thick cloth around the cap and turn it slowly to the first stop to release system pressure. When pressure is released, press the cap down (still using a cloth) and turn the rest of the way to remove it.

PRESSURE CAP TESTING

Inspection and Cleaning—Inspect both sides of the pressure cap rubber seal and the vacuum valve seat. Check for particles of rust or dirt that could impair sealing. Flush away any foreign matter with warm tap water. Also check the sealing shoulder in the expansion tank filler neck and wipe out any foreign matter present at this point.



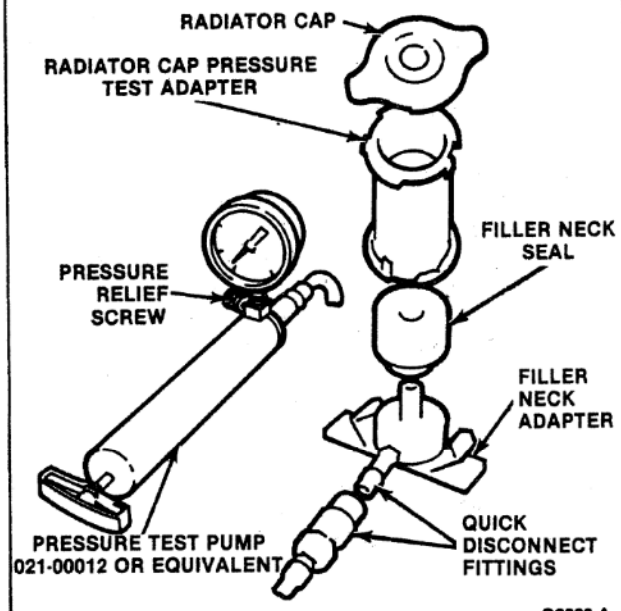


Pressure Test—With the pressure cap seal surfaces clean, install the cap on the radiator cap pressure test adapter of the pressure test kit (Rotunda 021-00012 or equivalent). The adapter is reversible to accept either deep or shallow neck caps.

DIAGNOSTIC PROCEDURES

PRESSURE CAP TESTING (Continued)

Install the filler neck seal on the filler neck adapter to seat in the deepneck end of the cap adapter. Connect the pump hose quick-disconnect fitting to the nipple on the filler neck adapter, and slowly depress the pump plunger while observing the pressure gauge. When the pressure stops increasing, note the reading obtained.

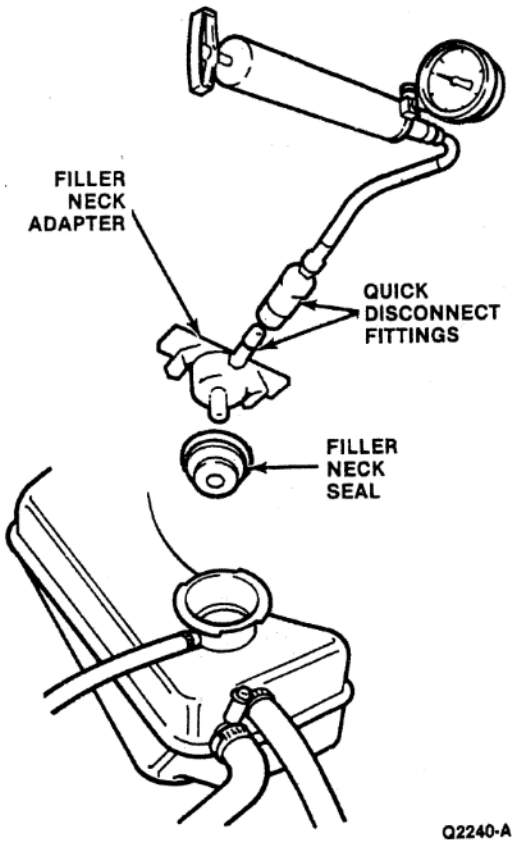


NOTE: Applying pressure too quickly can cause incorrect readings. Release pressure with the pressure relief screw. Repeat the test at least twice to verify that the pressure reading is repeatable and consistent. If the cap pressure is less than 96 kPa (14 psi) or more than 124 kPa (18 psi), replace the cap.

COOLING SYSTEM PRESSURE TESTING

System pressure testing is necessary when inspection and pressure cap testing do not identify the cause of coolant loss.

With system warm and pressure cap removed, install the test kit filler neck seal on the filler neck adapter large end first. Install the adapter on the expansion tank filler neck in place of the pressure cap. Connect the test pump quick-disconnect fitting to the nipple on the filler neck adapter and pressurize the system, if possible, to the relief pressure of the cap, found in the cap pressure test.



CAUTION: Do not, in any case, pressurize the system in excess of 138 kPa (20 psi).

DIAGNOSTIC PROCEDURES

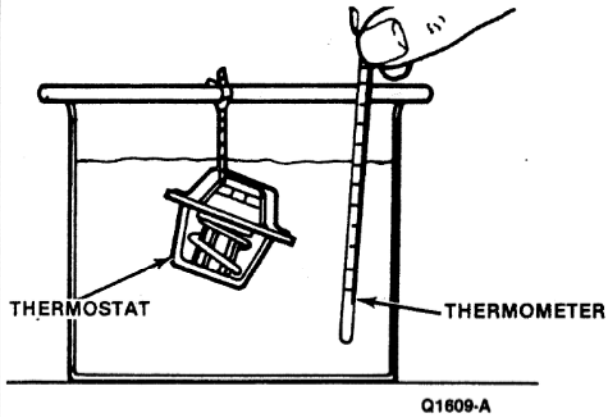
COOLING SYSTEM PRESSURE TESTING (Continued)

If the system can be pressurized to within 14 kPa (2 psi) of the cap pressure rating, let it stand for two minutes while watching the gauge. If the pressure holds, the system is not leaking. If it drops, check for leaks at all external cooling system connections as detailed under Inspection in this section, while maintaining pressure with the test pump. If no external leaks are found, refer to Section 21-05 for engine disassembly and inspection procedures.

THERMOSTAT TESTING

If overheating or failure to reach normal operating temperature indicate improper thermostat operation, the thermostat must be removed and temperature-tested. If necessary, refer to Section 27-03 for thermostat removal. Suspend the thermostat and an accurate thermometer in a pan of water so that they do not touch the bottom of the pan, and heat to boiling while observing the temperature. The thermostat should just begin to open at its rated temperature, 89 °C (192 °F), and be open at least 1/8 inch at 100 °C (212 °F).

To check for low temperature leakage, cool the thermostat to room temperature and hold it up against a lighted background while checking visually for light between valve and seat. If any light is visible, replace the thermostat with an approved original equipment replacement of the same temperature rating.



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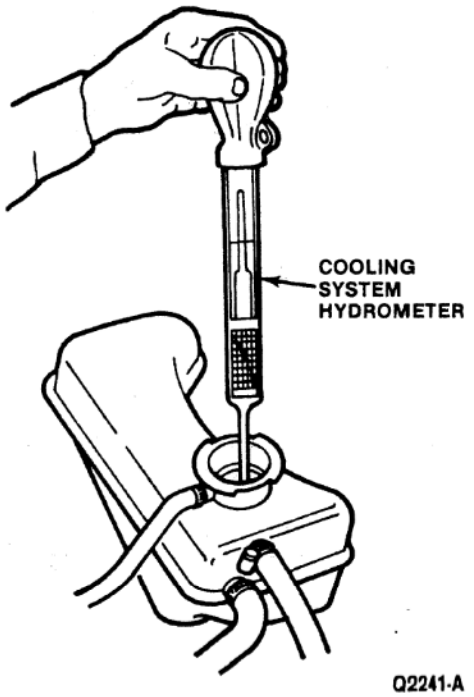
MAINTENANCE PROCEDURES

COOLANT LEVEL CHECK

Coolant level should be checked at least once a month. With a cold engine, the coolant level should be even with the "MAX" mark on the coolant expansion tank.

COOLANT CONDITION CHECK

With the pressure cap off, examine the coolant in the expansion tank. Draw a sample with a hydrometer. Check for rust, dirt or oil. Also check the freezing point. It should be approximately −37 °C (−35 °F) if the mixture has not been diluted by adding plain water. Dilution of the mixture below the recommended 50/50 concentration reduces the effectiveness of the corrosion inhibitors in the anti-freeze formula. If the mixture is diluted but not rusty or discolored, full protection may be restored by partially draining the system and adding 100 percent anti-freeze coolant, Peak Universal Formula ESE M97B44-A (E2FZ-19549-A), or equivalent.



Q2241-A

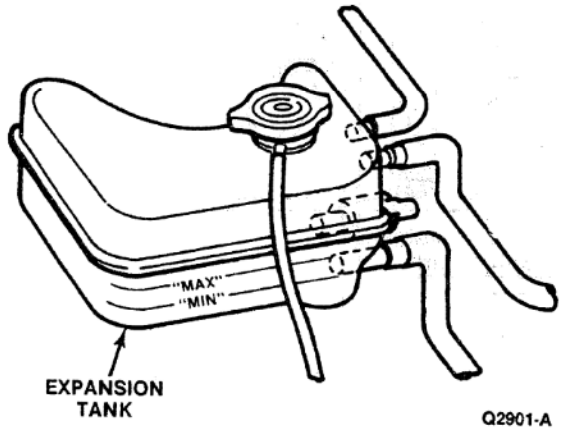
MAINTENANCE PROCEDURES (Continued)

Coolant Draining And Replacement

If coolant is discolored or dirty, or if inspection revealed hoses, gaskets, or other components requiring service or replacement, the coolant must be drained and discarded, or saved for reuse depending on its condition. Remove the pressure cap, observing precautions as previously described if the system is hot and pressurized. Disconnect the heater valve vacuum line to be sure the valve is open for heater core drainage. Position a drain pan under the radiator drain cock. Open the drain cock and drain the system. For radiator drain location, refer to Section 27-03.

Clean the cooling system by flushing with clear water. If excessively rusty or dirty, reverse pressure flushing or use an approved flushing compound. If necessary, refer to the flushing procedures in this Section.

Refill the system with equal parts of water and anti-freeze coolant meeting Ford specifications. Use Peak Universal Formula ESE-M97B44-A (E2FZ-19549-A), or equivalent. Fill to the MAX mark in the expansion tank and install the pressure cap only to the first stop (non-pressurizing). Start the engine and run at fast idle only until the radiator upper hose feels warm, indicating the thermostat has opened. Then stop the engine. Check the coolant level in the expansion tank and add coolant mixture if required to restore the level to the "MAX" mark. Fully install the pressure cap on the expansion tank.



Cooling System Flushing

When replacing coolant because of excessive rust or dirt, the system should be vigorously flushed to break up and remove deposits of sludge, rust, and foreign matter.

CAUTION: Do not use caustic cleaning solutions or copper/brass radiator cleaning agents on aluminum radiators. Internal cleaning of the aluminum tubes can only be done with sonic cleaning equipment.

Radiator and Engine Flush—If close-circuit pressure flushing equipment is not available, the cooling system may be reverse-pressure flushed with plain water as follows:

1. Drain the cooling system, remove the thermostat and reinstall the thermostat housing on the cylinder head. If necessary, refer to Section 27-03 for thermostat removal procedure.
2. Disconnect the radiator vent hose from the expansion tank and plug the end of the hose. (Manual transmission only.)
3. Disconnect the radiator fill tube (expansion tank to radiator) from the nipple below the lower hose connection. Plug or cap the nipple. (Manual transmission only.)
4. Disconnect the heater bypass supply line from the bypass nipple on the thermostat housing. Plug or cap the nipple.
5. Disconnect the bypass loop return line from the water pump and plug or cap the water pump nipple.
6. Disconnect the intake manifold outlet hose from the manifold nipple and plug or cap both nipple and hose.
7. Disconnect the turbocharger cooler line from the block water jacket outlet and plug or cap the block fitting and the connecting hose.
8. Disconnect the radiator lower hose from the radiator and position the hose to drain clear of the vehicle.

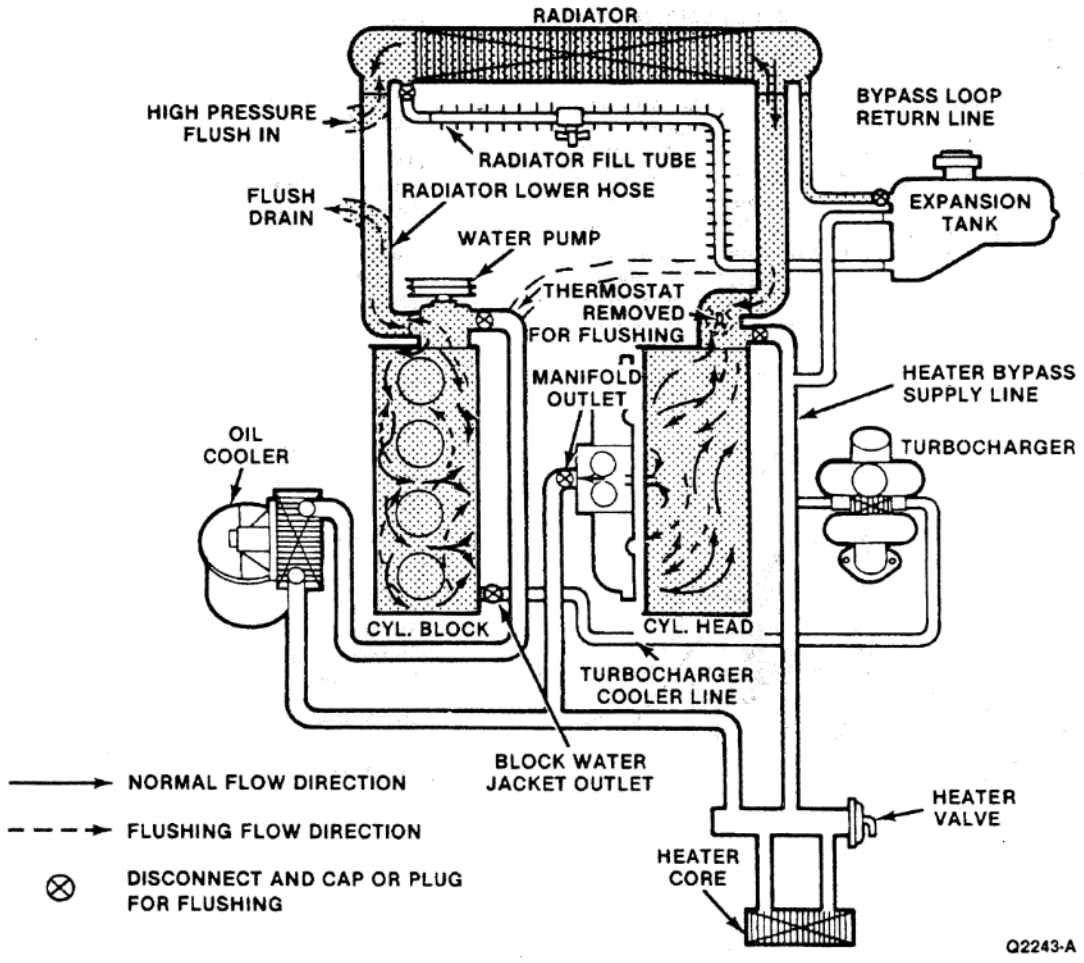
DIAGNOSTIC CHARTS

9. Connect a high-pressure hose to the radiator lower hose outlet. Back flush the radiator and engine until water runs clear out of the radiator lower hose. Turn water on and off several times, pulsing the flow to help break loose sludge deposits.

CAUTION: Flushing water flow must be limited so that pressure inside the radiator does not exceed 138 kPa (20 psi).

10. When the system drains clear, unplug the radiator vent hose. When water flows clear from the hose, re-plug it. (Manual transmission only.)
11. Also, run water into the expansion tank and verify that it drains freely out the radiator fill tube connecting hose at lower left. (Manual transmission only.)
12. Before reconnecting the cooling system hoses disconnected for the radiator and engine back-flush procedure, the heater bypass loop must be back-flushed separately to prevent loosened sediment from lodging in the heater core or oil cooler.

RADIATOR/ENGINE BACK FLUSH



MAINTENANCE PROCEDURES

COOLING SYSTEM FLUSHING (Continued)

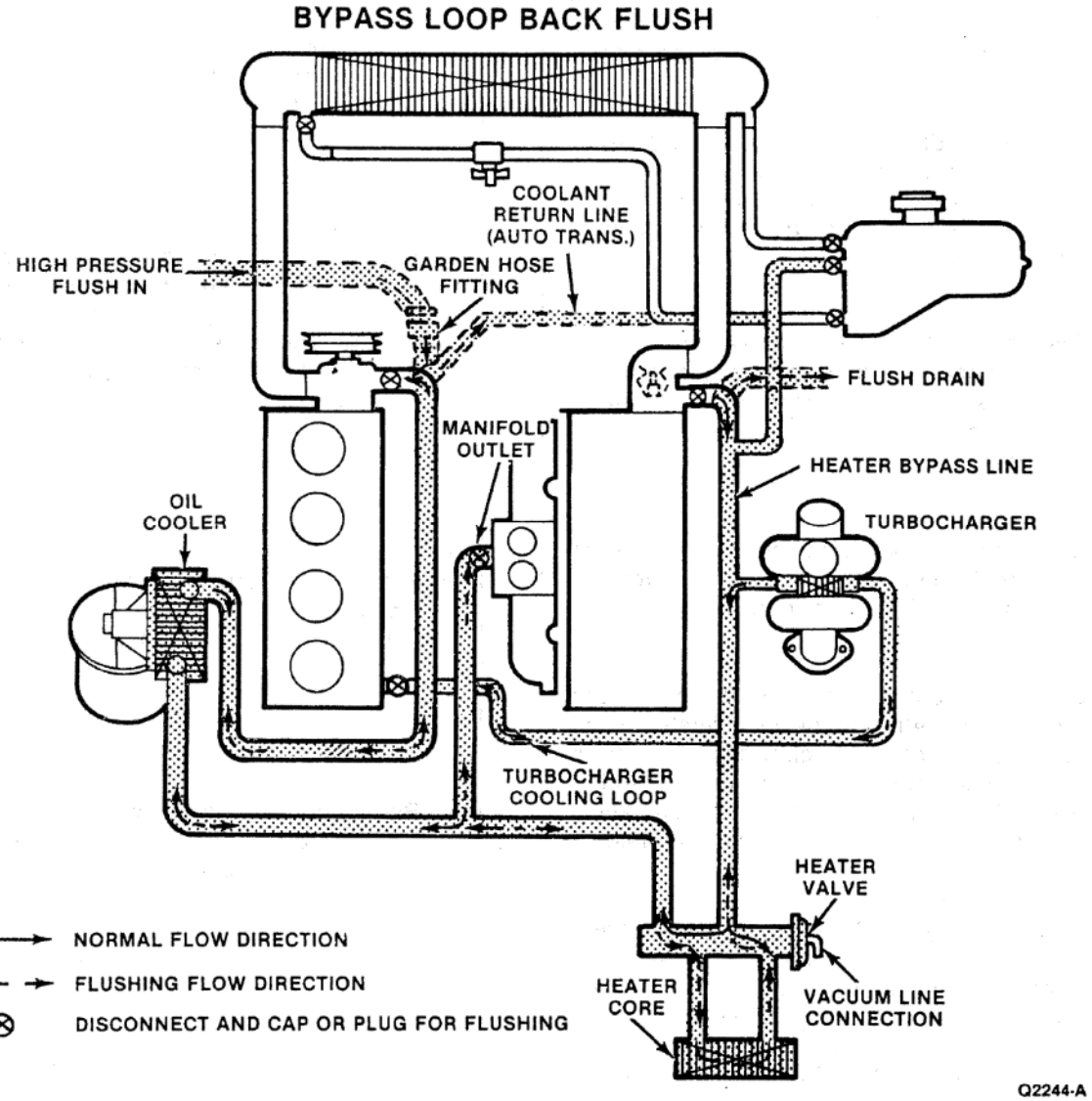
Bypass Loop Back Flush—Back-flushing the bypass loop, including heater core and oil cooler, has to be a separate operation to get the required flow, opposite to that of normal operation.

1. Install and clamp a garden hose female end fitting in the bypass loop return hose, disconnected from the water pump nipple.
2. Connect a drain hose or piece of pipe to the heater bypass line hose, disconnected from the thermostat housing bypass nipple. Position the drain line to discharge clear of the vehicle.
3. Disconnect the bypass line vent hose from the expansion tank and plug the end of the hose. Also, on automatic transmission vehicles, disconnect and plug the coolant return line.
4. Disconnect the vacuum line from the heater valve to be sure the valve is open for full flow through the heater core.
5. Connect a garden hose to the hose fitting in the bypass return hose and flush the oil cooler and heater core circuit until the drain water runs clear. Pulse the flow by turning the water on and off several times. Allow full flow for approximately five minutes.
6. Before turning off the water, unplug the end of the intake manifold hose and make sure clear drain water flows out of it. If necessary, pinch off the bypass line drain hose to increase pressure in the bypass loop. Replug the manifold hose when it drains clear.
7. Similarly, unplug the turbocharger cooling loop connecting hose to back-flush the cooler. Pinch the bypass line drain hose if necessary to initiate cooler back flow. Replug the cooler connecting hose.
8. Unplug the bypass line vent hose and pinch off the drain connection to verify that the vent hose is clear and unobstructed. Also, with automatic transmission, unplug the coolant return hose for flow check.
9. Shut off the flushing water supply and remove the adapters, caps, and plugs installed for the flushing operation. Reconnect all cooling system connections, tightening all hose clamps to 2.5 to 3.5 N·m (22 to 31 lb-in.).
10. Install the thermostat with a new housing gasket. If necessary, refer to Section 27-03 for thermostat installation.
11. Refill cooling system with approved antifreeze coolant mixture. If necessary, refer to coolant replacement procedure in this section.

MAINTENANCE PROCEDURES

COOLING SYSTEM FLUSHING (Continued)

12. With cooling system warmed up and pressurized, inspect all system connections for leaks and tighten as necessary.



DIAGNOSIS CHARTS

COOLING FAN

Cooling Fan System Check

CHECK	RESULTS	ACTION
SYSTEM CHECK 1 Turn ignition switch to POSITION II (RUN) and turn A/C switch to ON position. **NOTE:** Engine does not have to be running.	Engine fan runs.	System is operating properly.
	Engine fan does not run.	Refer to Diagnostic Condition 1.
SYSTEM CHECK 2 Make sure A/C switch is in O (OFF) position. Run engine until coolant temperature reaches 122 °C ± 3 °C (221 °F ± 6 °F). **NOTE:** If necessary, partially block air flow through radiator to increase coolant temperature to 122 °C ± 3 °C (221 °F ± 6 °F).	Engine and A/C fans run.	System is operating properly.
	Engine fan runs but A/C fan does not.	Refer to Diagnostic Condition 2.
	Engine cooling fan does not run but A/C fan does.	Refer to Diagnostic Condition 3.
	A/C and engine fans do not run.	Refer to Diagnostic Condition 4.
SYSTEM CHECK 3 Disconnect wire from engine coolant temperature switch and connect A/C gauge set. Set A/C controls for maximum cooling and open the vehicle doors. **NOTE:** If necessary, partially block air flow over condenser to increase high side pressure to 175 kPa (154 psi). Start engine, bring to normal operating temperature, and curb idle.	Engine fan runs when A/C switch is turned ON. A/C fan comes ON when A/C high side pressure reaches 175 kPa (254 psi).	System is operating properly.
	A/C fan does not come on at specified pressure.	Proceed to Diagnostic Condition 5.

CQ2179-A1

DIAGNOSIS CHARTS

COOLING FAN

Diagnostic Condition 1. Engine Cooling Fan Does Not Operate with A/C Switch

CHECK	RESULTS	ACTION
CIRCUIT CHECK 1.1 Turn ignition switch to Position II (RUN) and turn A/C switch to ON position.	Engine fan runs.	System is operating properly.
	Engine fan does not run.	Proceed to Circuit Check 1.2. Turn ignition and A/C switches off.
CIRCUIT CHECK 1.2 Check fuse link at fan relay.	Fuse link open.	Replace fuse link and check for shorts to ground in circuits 54-31 and 54-31A.
	Fuse link OK.	Proceed to Circuit Check 1.3.
CIRCUIT CHECK 1.3 Disconnect wiring connector at engine fan, turn ignition switch to Position II (RUN) and turn A/C switch to ON position. Using a voltmeter, check for battery voltage at motor feed terminal (black-red stripe).	Battery voltage measured.	Proceed to Circuit Check 1.4.
	Battery voltage not measured.	Proceed to Circuit Check 1.5. Connect engine fan wiring. Turn ignition and A/C switches off.
CIRCUIT CHECK 1.4 Connect a jumper wire from engine fan ground wire terminal (brown-black stripe) to a clean chassis ground, turn ignition switch to Position II (RUN) and turn A/C switch to ON position.	Engine fan does not run.	Replace fan motor.
	Engine fan runs.	Repair open in motor ground circuit. Remove jumper wire. Turn ignition and A/C switches off.

CQ2179-A2

DIAGNOSIS CHARTS

COOLING FAN

Diagnostic Condition 1: Engine Cooling Fan Does Not Operate with A/C Switch (Cont'd)

CHECK	RESULTS	ACTION
CIRCUIT CHECK 1.5 Using a voltmeter, check for battery voltage at engine fan relay motor feed terminal (black-red stripe), turn ignition switch to Position II (RUN) and turn A/C switch to ON position.	Battery voltage measured.	Repair open in circuit from relay to motor.
	Battery voltage not measured.	Proceed to Circuit Check 1.6. Turn ignition and A/C switches off.
CIRCUIT CHECK 1.6 Using a voltmeter, check for battery voltage at engine fan relay battery terminal (red).	Battery voltage not measured.	Repair open in engine relay battery feed wire.
	Battery voltage measured.	Proceed to Circuit Check 1.7.
CIRCUIT CHECK 1.7 Using a voltmeter, check for battery voltage at engine fan relay coil terminal (black-white stripe), turn ignition switch to Position II (RUN) and turn A/C switch to ON position.	Battery voltage not measured.	Proceed to Circuit Check 1.9.
	Battery voltage measured.	Proceed to Circuit Check 1.8.
CIRCUIT CHECK 1.8 Connect a jumper wire from engine fan relay ground terminal (brown-black stripe) to a clean chassis ground, turn ignition switch to Position II (RUN) and turn A/C switch to ON position.	Engine fan does not run.	Replace engine fan relay.
	Engine fan runs.	Repair open in engine fan relay ground circuit.

CQ2179-A3

DIAGNOSIS CHARTS

COOLING FAN

Diagnostic Condition 1: Engine Cooling Fan Does Not Operate with A/C Switch (Cont'd)

CHECK	RESULTS	ACTION
CIRCUIT CHECK 1.9 Using a voltmeter, check for battery voltage at A/C switch engine fan relay terminal (buss bar with black-white stripe wire), turn ignition switch to Position II (RUN) and turn A/C switch to ON position.	Battery voltage not measured.	Proceed to Circuit Check 1.10.
	Battery voltage measured.	Repair open in wire from A/C switch to engine fan relay.

CQ2179-A4

Diagnostic Condition 2: Engine Cooling Fan Operates with Engine Coolant Temperature above 122 °C ± 3 °C (221 °F ± 6 °F) but A/C Fan Does Not Operate

CHECK	RESULTS	ACTION
CIRCUIT CHECK 2.1 With engine coolant temperature at 122 °C ± 3 °C (221 °F ± 6 °F), A/C and engine cooling fans should operate.	A/C fan comes on at specified coolant temperature.	System is operating properly.
	A/C fan does not come on.	Proceed to Circuit Check 2.2.
CIRCUIT CHECK 2.2 Check fuse link at A/C fan relay.	Fuse link open.	Replace fuse link and check for shorts to ground in circuit 54-31 and 54-31A.
	Fuse link OK.	Proceed to Circuit Check 2.4.
CIRCUIT CHECK 2.3 Connect jumper wire from battery positive terminal to motor connector battery terminal (black-red stripe) and connect jumper wire from motor connector ground terminal to a clean chassis ground (brown).	A/C fan does not run.	Replace motor.
	A/C fan runs.	Proceed to Circuit Check 2.4. Remove jumper wires.

CQ2179-A5

DIAGNOSIS CHARTS

COOLING FAN

Diagnostic Condition 2: Engine Cooling Fan Operates with Engine Coolant Temperature above 122 °C ± 3 °C (221 °F ± 6 °F) but A/C Fan Does Not Operate (Cont'd)

CHECK	RESULTS	ACTION
CIRCUIT CHECK 2.4 Using a voltmeter, check for battery voltage at A/C fan relay motor terminal (black-red stripe) and turn ignition switch to Position II (RUN).	Voltage measured.	Repair open in wire from relay to motor.
	Voltage not measured.	Proceed to Circuit Check 2.5. Remove jumper wire at A/C pressure switch. Turn ignition switch off.
CIRCUIT CHECK 2.5 Connect jumper wire from A/C fan relay coil ground terminal (brown-black stripe) to a clean chassis ground and turn ignition switch to Position II (RUN).	A/C fan runs.	Repair open in wire from relay to pressure switch.
	A/C fan does not run.	Leave jumper wire connected and proceed to Circuit Check 2.6. Turn ignition switch off.
CIRCUIT CHECK 2.6 Using a voltmeter, check for battery voltage at A/C fan relay battery terminal (red).	Voltage not measured.	Repair open in A/C relay battery feed circuit.
	Voltage measured.	Proceed to Circuit Check 2.7. Turn ignition switch off.
CIRCUIT CHECK 2.7 Using a voltmeter, check for battery voltage at A/C fan relay coil feed terminal (black-yellow and red stripe) and turn ignition switch to Position II (RUN).	Voltage measured.	Replace A/C fan relay.
	Voltage not measured.	Proceed to Circuit Check 2.8. Turn ignition switch off.
CIRCUIT CHECK 2.8 Using a voltmeter, check for battery voltage at A/C fan relay coil feed terminal (black-yellow and red stripe) and turn ignition switch to Position II (RUN).	Battery voltage measured.	Repair open in wire from A/C switch to A/C fan relay.
		After making this repair, A/C fan should operate.

CQ2179-A6

DIAGNOSIS CHARTS

COOLING FAN

Diagnostic Condition 3: Engine Cooling Fan Does Not Operate with Engine Coolant Temperature above 122 °C ± 3 °C (221 °F ± 6 °F) but A/C Fan Does Operate

CHECK	RESULTS	ACTION
CIRCUIT CHECK 3.1 With engine coolant temperature above 122 °C ± 3 °C (221 °F ± 6 °F), engine cooling and A/C fans should both operate.	Engine cooling fan comes on at specified temperature.	System is operating properly.
	Engine cooling fan does not come on but A/C fan comes on.	Proceed to Circuit Check 3.2.
CIRCUIT CHECK 3.2 Connect a jumper wire from temperature/pressure relay ground terminal (brown-black stripe) to a clean chassis ground.	Engine fan runs.	Repair open in wire from temperature/pressure relay to ground.
	Engine fan does not run.	Proceed to Circuit Check 3.3.
CIRCUIT CHECK 3.3 Using a voltmeter, check for battery voltage at temperature/pressure switch relay coil terminal (red-yellow stripe).	Voltage not measured.	Proceed to Circuit Check 3.7.
	Voltage measured.	Proceed to Circuit Check 3.4.
CIRCUIT CHECK 3.4 Using a voltmeter, check for battery voltage at temperature/pressure relay battery terminal (buss bar with red-blue stripe wire).	Voltage not measured.	Repair open in wire from temperature/pressure switch relay terminal to temperature/pressure relay battery terminal.
	Voltage measured.	Proceed to Circuit Check 3.5.
CIRCUIT CHECK 3.5 Connect a jumper wire from the temperature/pressure relay ground terminal (brown-black stripe) to a clean chassis ground. Using a voltmeter, check for battery voltage at engine fan relay coil terminal (black-yellow and red stripe).	Voltage not measured.	Replace temperature/pressure relay.
	Voltage measured.	Proceed to Circuit Check 3.6.

CQ2179-A7

DIAGNOSIS CHARTS

COOLING FAN

Diagnostic Condition 3: Engine Cooling Fan Does Not Operate with Engine Coolant Temperature above 122 °C ± 3 °C (221 °F ± 6 °F) but A/C Fan Does Operate (Cont'd)

CHECK	RESULTS	ACTION
CIRCUIT CHECK 3.6 Connect a jumper wire from temperature/pressure relay ground terminal (brown-black stripe) to a clean chassis ground. Using a voltmeter, check for battery voltage at engine fan relay coil terminal (black-yellow and red stripe).	Voltage not measured.	Repair open in wire from temperature/pressure switch relay to engine fan relay. After making this repair, the engine cooling fan should operate properly.

Diagnostic Condition 4: A/C and Engine Fans Do Not Operate with Engine Coolant Temperature above 122 °C ± 3 °C (221 °F ± 6 °F)

CHECK	RESULTS	ACTION
CIRCUIT CHECK 4.1 With engine coolant temperature above 122 °C ± 3 °C (221 °F ± 6 °F), A/C and engine cooling fans should operate.	A/C and engine fans come on at specified temperature.	System is operating properly.
	A/C and engine fans do not come on at specified temperature.	Proceed to Circuit Check 4.2.

CQ2179-A8

DIAGNOSIS CHARTS

COOLING FAN

Diagnostic Condition 4: A/C and Engine Fan Do Not Operate with Engine Coolant Temperature above 122 °C ± 3 °C (221 °F ± 6 °F) (Cont'd)

CHECK	RESULTS	ACTION
CIRCUIT CHECK 4.2 Disconnect wire from coolant temperature switch and connect a jumper wire from wire terminal (brown-black stripe) to a clean chassis ground and turn ignition switch to Position II (RUN).	A/C and engine fans come on.	Replace engine coolant temperature switch.
	A/C and engine cooling fans do not come on.	Proceed to Circuit Check 4.3. Turn ignition switch off. Remove jumper wire and connect temperature switch wire.
CIRCUIT CHECK 4.3 Check fuse links at relays.	Fuse links open.	Replace fuse links and check for shorts to ground in circuits 54-31 and 54-31A. After making this repair, the A/C and engine fans should operate.

CQ2179-A9

DIAGNOSIS CHARTS

COOLING FAN

Diagnostic Condition 5: A/C Fan Does Not Operate When Refrigerant Pressure on High Side Reaches 175 kPa (254 psi) but Engine Fan Operates

CHECK	RESULTS	ACTION
CIRCUIT CHECK 5.1 Connect A/C gauge set and check for proper operation of the A/C refrigerant system.	A/C refrigerant system not operating properly.	Refer to Section 31-01 for testing procedures.
	A/C refrigerant system operating properly.	Repair system and recheck operation of A/C fan. Proceed to Circuit Check 5.2.
CIRCUIT CHECK 5.2 Disconnect wire from engine coolant temperature switch, connect A/C gauge set, set A/C controls for maximum cooling and open the vehicle doors. **NOTE:** If necessary, partially block airflow over condenser to increase high side pressure to 175 kPa (254 psi).	Engine fan comes on with A/C switch and A/C fan comes on when high side refrigerant pressure reaches 175 kPa (254 psi).	System is operating properly.
	A/C fan does not come on when high side pressure reaches 175 kPa (254 psi).	Proceed to Circuit Check 5.3. Connect coolant temperature switch wire.
CIRCUIT CHECK 5.3 Connect a jumper wire from A/C pressure switch ground terminal (yellow-red stripe) to a clean chassis ground and turn ignition switch to Position II (RUN).	A/C fan comes on.	Replace A/C pressure switch.
	A/C fan does not come on.	Proceed to Circuit Check 5.4. Turn ignition switch off. Remove jumper wire.
CIRCUIT CHECK 5.4 Connect a jumper wire from A/C fan relay coil ground terminal (brown-black stripe) to a clean chassis ground and turn ignition switch to Position II (RUN).	A/C fan comes on.	Repair open in wire from A/C fan relay to A/C pressure switch. After making this repair, the A/C fan should operate.

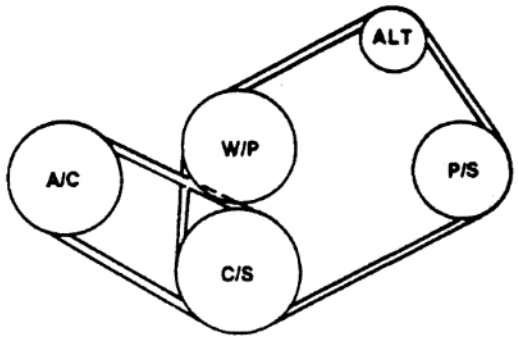
CQ2179-A10

SECTION 27-02 Drive Belts

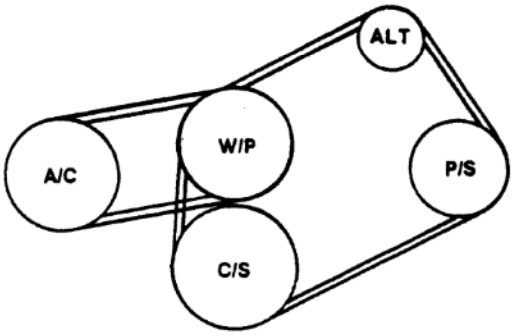
SUBJECT	PAGE
ADJUSTMENTS	
A/C Compressor Drive Belt Tension	27-02-4
Alternator Drive Belt Tension	27-02-3
DESCRIPTION	27-02-1
DRIVE BELT APPLICATION	27-02-5
REMOVAL AND INSTALLATION	
A/C Compressor Drive Belt	27-02-5
Alternator Drive Belt	27-02-5

DESCRIPTION

A matched set of cogged V belts drives the water pump, alternator, and power steering pump.



1985 MANUAL TRANSMISSION
BELT ARRANGEMENT



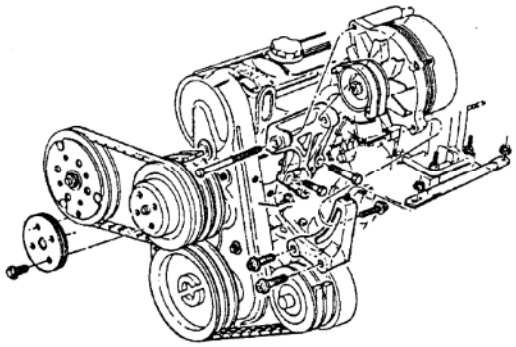
1985 AUTOMATIC TRANSMISSION
AND ALL 1986 AND 1987
MODEL BELT ARRANGEMENT

Q2902-A

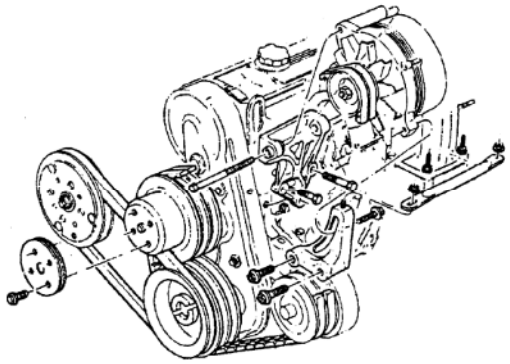
DESCRIPTION (Continued)

The A/C compressor is separately driven by a single conventional V belt.

Belts must be properly adjusted at all times. Loose-fitting belts will result in slippage which may cause a noise complaint or improper accessory operation (alternator will not charge, etc.). Also, overtightening the accessory drive belts will place an unnecessary load on the accessory bearings.



1985 AUTOMATIC TRANSMISSION APPLICATIONS
1986 ALL
1987 ALL



1985 MANUAL TRANSMISSION APPLICATIONS

Q2903-A

ADJUSTMENTS

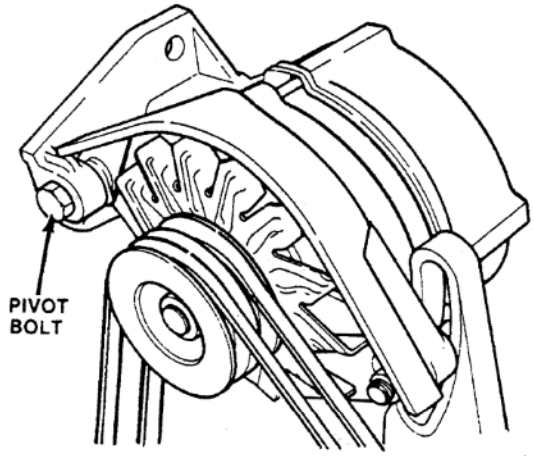
Alternator Drive Belt Tension

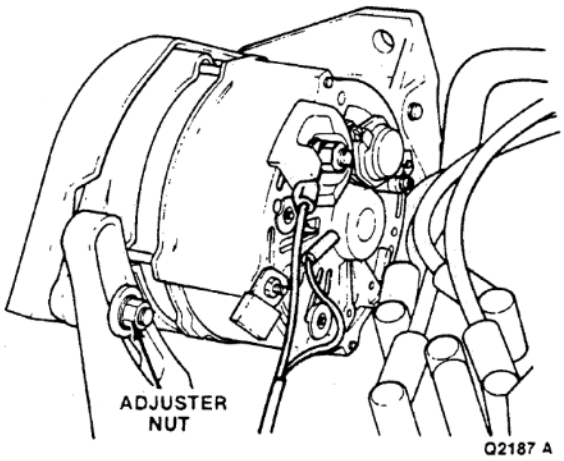
SPECIAL SERVICE TOOLS REQUIRED:

T63L-8620-A Belt Tension Gauge

NOTE: If the drive belts have been in service for some time, inspect them before attempting an adjustment. Conditions requiring drive belt replacement are excessive wear, severe glazing, frayed cords, cracks, or oil contamination. Minor cracks in the back of the belt are considered acceptable.

1. Inspect the condition of the drive belts.
2. Loosen the belt adjuster pivot bolt and adjuster nut at the alternator.

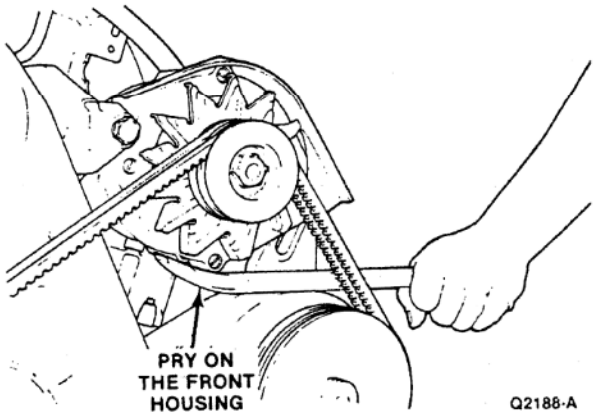




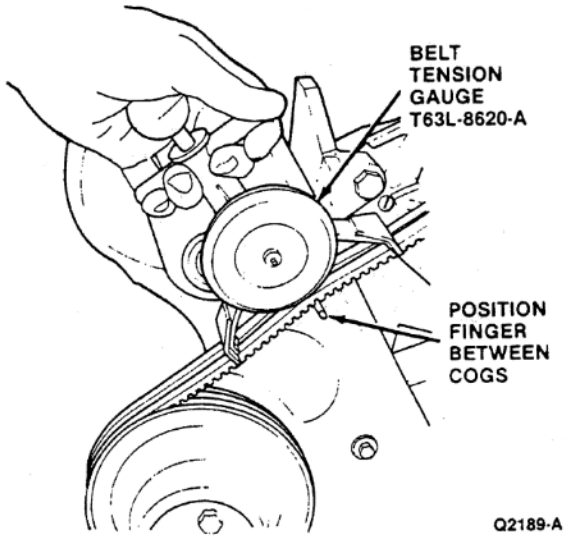
3. Adjust the tension of the belts, using Belt Tension Gauge T63L-8620-A, or equivalent, and the following specifications:

   New Belts (no run time): 55 to 75 Kg (120 to 160 lb).

   Used Belts (more than 10 minutes of run time): 50 to 60 Kg (110 to 130 lb).



NOTE: When adjusting a cogged V belt of this type, position the tensioner on the longest accessible span with the gauge finger between two of the cogs.



ADJUSTMENTS (Continued)

4. Tighten the adjuster pivot bolt to 60 to 81 N·m (44 to 60 lb-ft) and the adjuster nut to 40 to 62 N·m (30 to 46 lb-ft).

NOTE: If the belt tension gauge is not available, the belt deflection method may be used.

a. Press firmly on belt.

b. Deflection should be as follows:

- 3 to 6mm (1/8 to 1/4 in.) for belts spanning less than 300mm (12 in.).
- 3 to 10mm (1/8 to 3/8 in.) for belts spanning more than 300mm (12 in.).

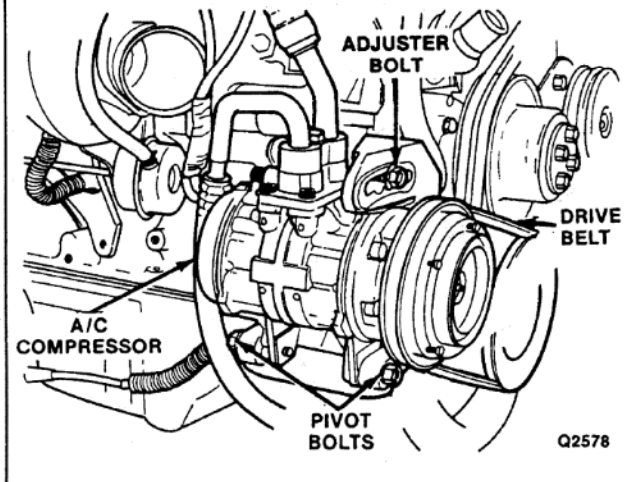
A/C Compressor Drive Belt Tension

SPECIAL SERVICE TOOLS REQUIRED:

T63L-8620-A Belt Tension Gauge

NOTE: If the drive belt has been in service for some time, inspect it before attempting an adjustment. Conditions requiring drive belt replacement are excessive wear, severe glazing, frayed cords, cracks, or oil contamination. Minor cracks in the back of the belt are considered acceptable.

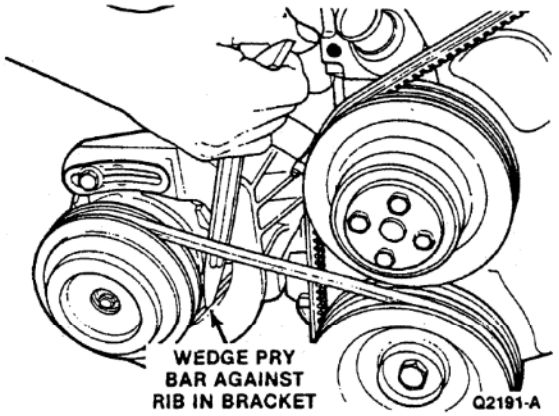
1. Inspect the condition of the drive belt.
2. Loosen the pivot bolts and adjuster bolt at the A/C compressor.

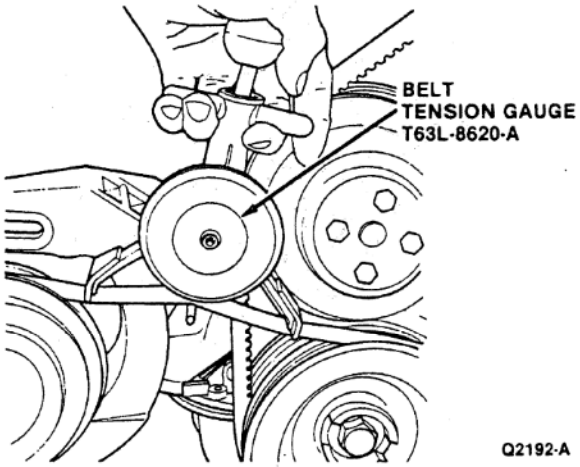


3. Adjust the tension of the belt, using Belt Tension Gauge T63L-8620-A, or equivalent, and the following specifications:

   New Belt (no run time): 55 to 75 Kg (120 to 160 lb).

   Used Belt (more than 10 minutes of run time): 50 to 60 Kg (110 to 130 lb).





4. Tighten the pivot bolts and the adjuster bolt to 60 to 81 N·m (44 to 60 lb-ft).

NOTE: If the belt tension gauge is not available, the belt deflection method may be used.

a. Press firmly on belt.

b. Deflection should be as follows:

- 3 to 6mm (1/8 to 1/4 in.) for belts spanning less than 300mm (12 in.).
- 3 to 10mm (1/8 to 3/8 in.) for belts spanning more than 300mm (12 in.).

REMOVAL AND INSTALLATION

A/C Compressor Drive Belt

Removal

Loosen the drive belt adjusting bolts at the A/C compressor, rotate the compressor toward the engine, and remove the drive belt.

Installation

1. Position the drive belt over the pulley on the crankshaft (or water pump as appropriate) and A/C compressor.
2. Adjust the tension of the belts, using Belt Tension Gauge T63L-8620-A, or equivalent. If necessary, refer to the procedure in this Section.
3. Tighten the pivot and adjuster bolts to 60 to 81 N·m (44 to 60 lb-ft).

Alternator Drive Belt

Removal

1. Remove the A/C compressor drive belt. If necessary, refer to the procedure in this Section.
2. Loosen the drive belt adjusting bolts at the alternator, rotate the alternator downward, and remove the drive belts.

Installation

NOTE: If new belts are being installed, they must be replaced as a matched set.

1. Position the drive belts over the pulleys on the crankshaft, alternator, water pump, and power steering pump.
2. Adjust the tension of the belts, using Belt Tension Gauge T63L-8620-A, or equivalent. If necessary, refer to the procedure in this Section.
3. Tighten the adjuster pivot bolt to 60 to 81 N·m (44 to 60 lb-ft) and the adjuster nut to 40 to 62 N·m (30 to 46 lb-ft).
4. Install the A/C compressor drive belt. If necessary, refer to the procedure in this Section.

DRIVE BELT APPLICATION

APPLICATION	FORD SERVICE PART	MOTORCRAFT
Alternator/Power Steering	E3TZ-8620-N	JB-546-L
Air Conditioning Compressor	E6PZ-8620-B	JB-361-L

CV7157-A

SECTION 27-03 Cooling System

SUBJECT	PAGE
DESCRIPTION AND OPERATION	
Air Dam	27-03-3
Cooling Fan	27-03-2
Cooling System	27-03-1
Heater Valve	27-03-9
Oil Cooler	27-03-9
Radiator	27-03-4
Radiators	27-03-3

SUBJECT	PAGE
DESCRIPTION AND OPERATION (Cont'd.)	
Thermostat	27-03-8
Water Pump	27-03-6
REPAIRS	
Cleaning	27-03-9
Leak Repair	27-03-10
Leak Testing	27-03-9

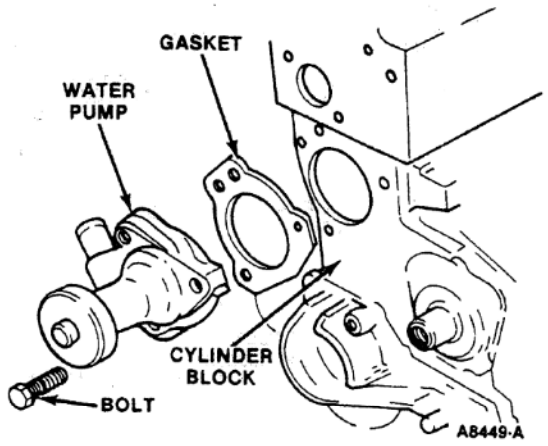
DESCRIPTION AND OPERATION

Cooling System

In addition to basic cooling system components—radiator, water pump, thermostat and fan—the XR4Ti cooling system also includes an expansion tank, overflow recovery bottle, air bleed vent lines, a water-jacketed intake manifold, engine oil cooler, automatic transmission oil cooler (in vehicles so equipped), a turbocharger cooling loop, vacuum-operated heater valve and a low-coolant warning sensor.

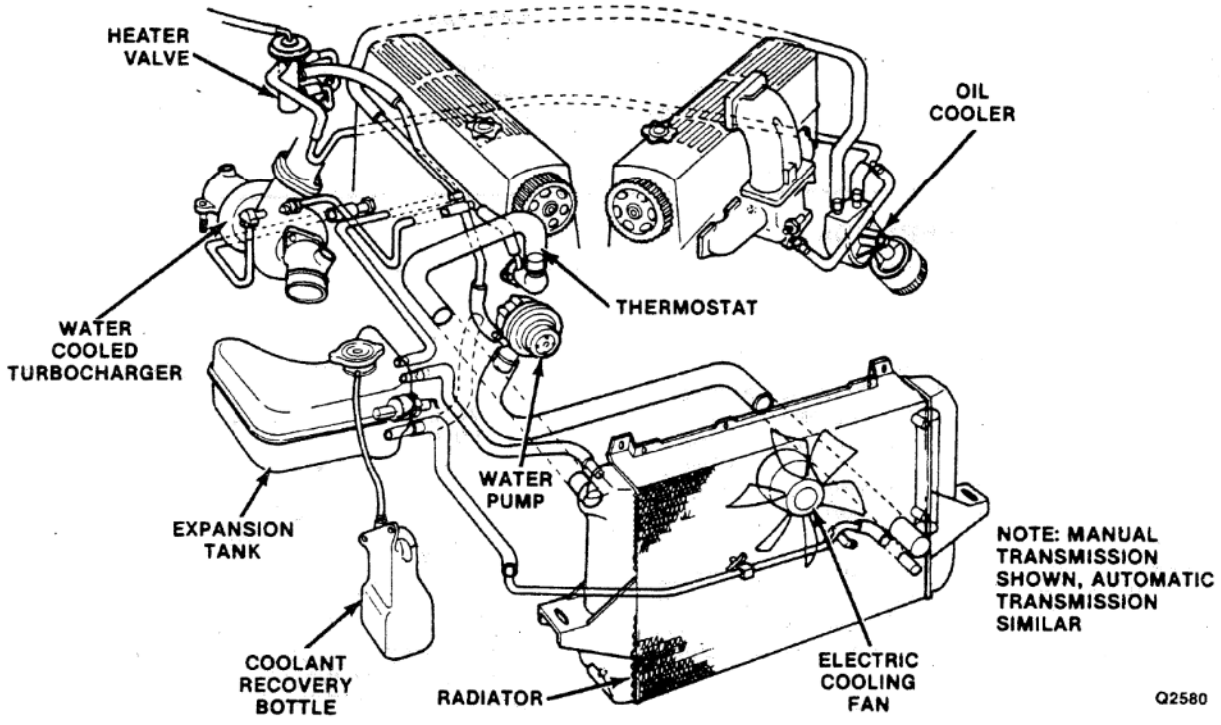
Coolant circulation is by conventional centrifugal pump, discharging into the front of the engine block and driven by the crankshaft pulley through dual V-belts which also drive the alternator and power steering pump.

There is no radiator cap, as such, because the system fill and pressure cap is located on the expansion tank, mounted just ahead of the right shock tower. High-level vent lines connect the engine, and the radiator in vehicles equipped with manual transmission, to the expansion tank to provide automatic bleeding action and prevent air from being trapped in the system.



DESCRIPTION AND OPERATION (Continued)

A thermostat bypass circuit routes part of the coolant flow through the heater core, oil cooler and manifold jacketing. When the engine is cold and the thermostat closed, this circuit is the primary flow path, distributing combustion heat throughout the engine for quick, uniform warmup. As the coolant reaches operating temperature the thermostat opens to route enough of the coolant flow through the radiator to limit coolant temperature to the operating value of the thermostat, but does not cut off the bypass flow through the heater and oil cooler.

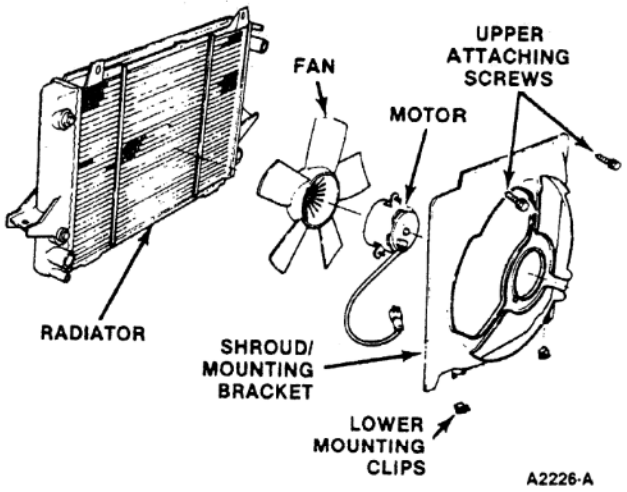


Cooling Fan

The cooling fan is separately driven by an electric motor controlled by coolant temperature. A thermostatic switch in the intake manifold water jacket closes to actuate the fan whenever coolant temperature reaches 210°F (98°C).

WARNING: STAY CLEAR OF THE COOLING FAN, SINCE INCREASED COOLANT TEMPERATURE MAY CAUSE IT TO START AT ANY TIME, EVEN WITH THE IGNITION SWITCH OFF.

NOTE: A detailed description of the electric cooling fan and related service procedures can be found in Section 27-10.

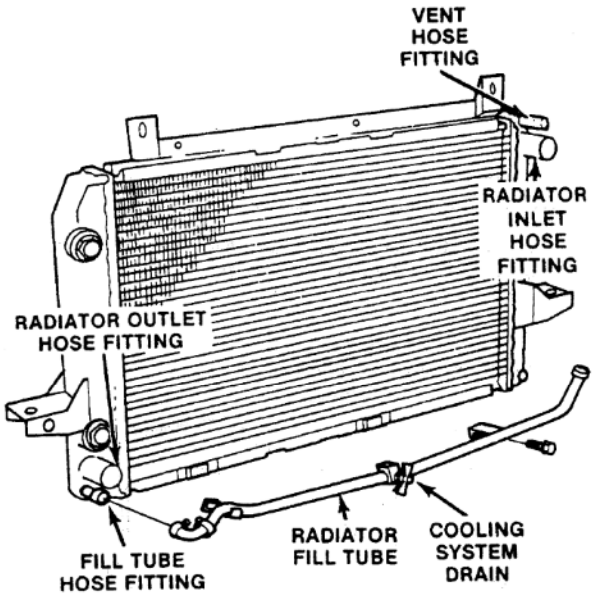


DESCRIPTION AND OPERATION (Continued)

Radiators

The radiators are a crossflow type with plastic end tanks. Core material and system connections differ depending on transmission equipment. With manual transmission, a copper/brass core is used, with two auxiliary hose connections to the expansion tank in addition to the main inlet and outlet hose connections to the engine. These auxiliary connections admit coolant from the expansion tank to the bottom of the radiator, and bleed air from the top back to the expansion tank, to keep the radiator full of coolant at all times. The manual transmission radiator does not include an integral drain valve, and an external drain cock is incorporated in the fill tube from the expansion tank to the bottom of the radiator.

RADIATOR FROM MANUAL TRANSMISSION EQUIPPED VEHICLE

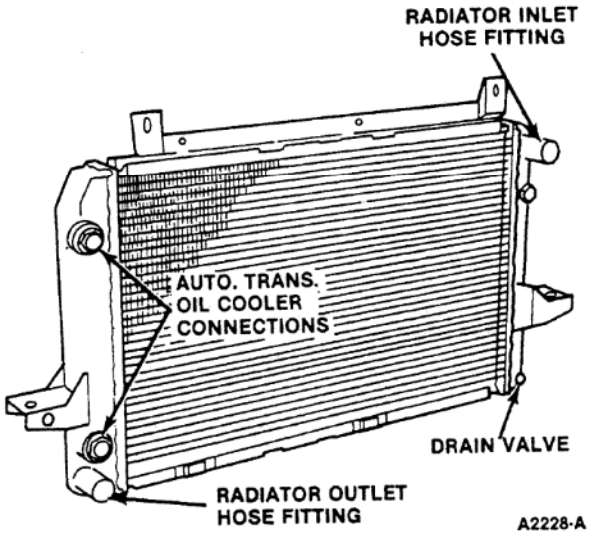


A2227-A

In automatic transmission equipped vehicles, an aluminum-core radiator is used, with the inlet hose fitting located higher in the right end tank. Air entrapment is minimal, and air bleed and fill connections are not required to keep the radiator full. The automatic transmission radiator includes an integral drain valve at the bottom of the right end tank, and a transmission oil cooler mounted in the left end tank. This threaded plug has a recessed "x" in the face to accept a large screwdriver or other flat bladed tool. To drain the coolent from the vehicle's radiator, remove the drain valve from the radiator.

Radiator disassembly is not recommended, since radiator parts are not serviced separately.

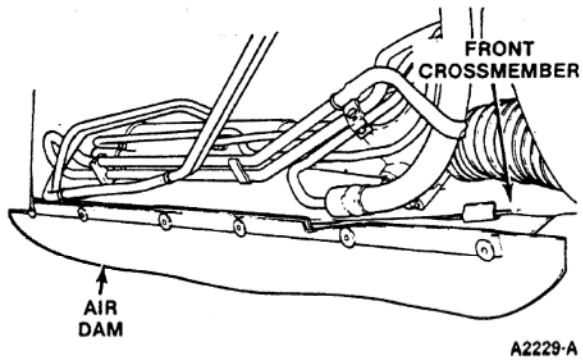
RADIATOR FROM AUTOMATIC TRANSMISSION EQUIPPED VEHICLE



A2228-A

Air Dam

Also included in the cooling system is a flexible air deflector, or dam, mounted on the frame front crossmember to increase cooling air flow through the radiator. This deflector must not be left off as cooling system performance would be impaired. Care should be exercised in hoisting, jacking or towing the vehicle to avoid damaging the deflector, and, if it is cut, torn or incomplete, it should be replaced.



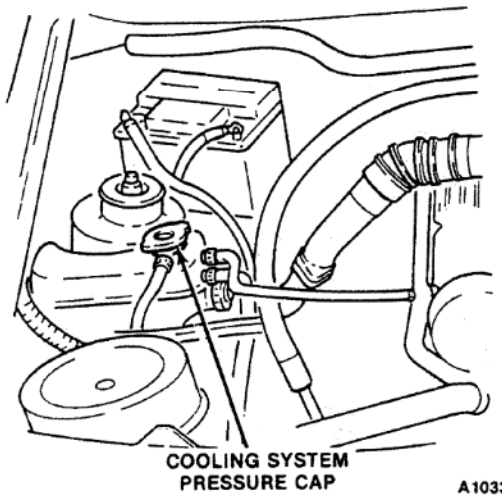
A2229-A

DESCRIPTION AND OPERATION (Continued)

Radiator

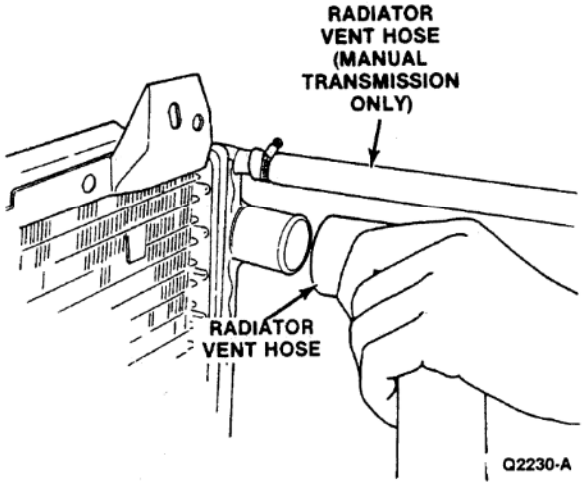
Removal

1. Remove the cooling system pressure cap from expansion tank filler neck. If the system is hot and pressurized, be careful to release pressure before fully opening it.

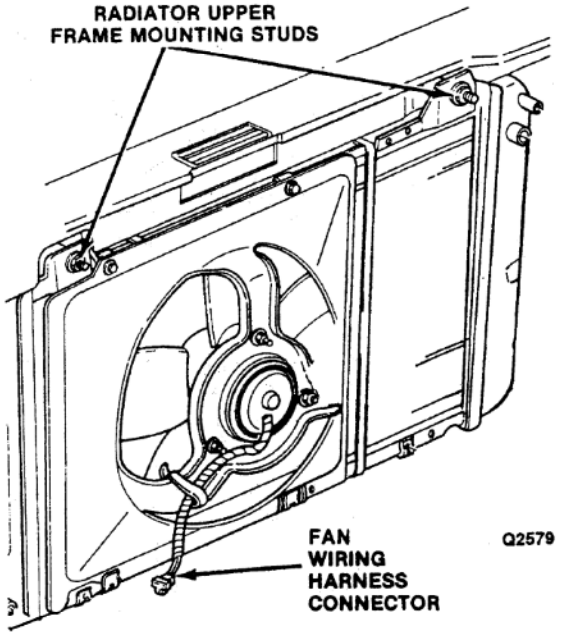


WARNING: NEVER REMOVE THE RADIATOR CAP UNDER ANY CONDITIONS WHILE THE ENGINE IS OPERATING. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN ENGINE AND/OR PERSONAL INJURY. TO AVOID HAVING SCALDING HOT COOLANT OR STEAM BLOW OUT OF THE RADIATOR, USE EXTREME CARE WHEN REMOVING THE CAP FROM A HOT RADIATOR. WAIT UNTIL THE ENGINE HAS COOLED; THEN, WRAP A THICK CLOTH AROUND THE RADIATOR CAP AND TURN IT SLOWLY TO THE FIRST STOP. STEP BACK WHILE THE PRESSURE IS RELEASED FROM THE COOLING SYSTEM. WHEN YOU ARE SURE ALL THE PRESSURE HAS BEEN RELEASED, PRESS DOWN ON THE CAP (STILL WITH A CLOTH), TURN AND REMOVE IT.

2. Disconnect the radiator upper hose from the radiator inlet. On manual transmission equipped vehicles, disconnect the radiator vent hose.



3. Remove two nuts securing the radiator upper frame to the engine compartment front panel.

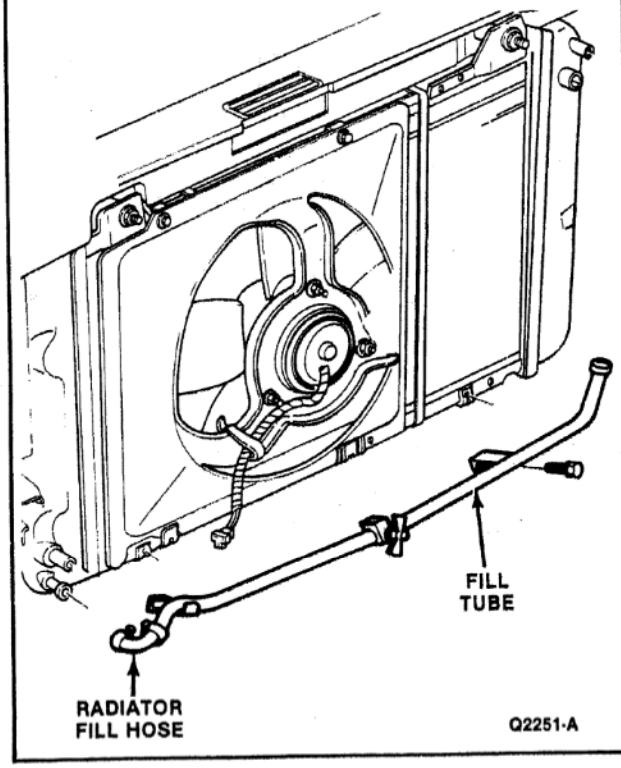


REMOVAL AND INSTALLATION

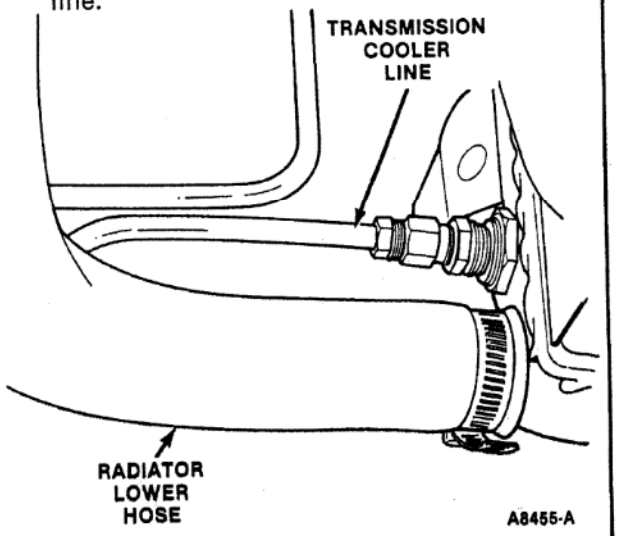
RADIATOR

Removal (Continued)

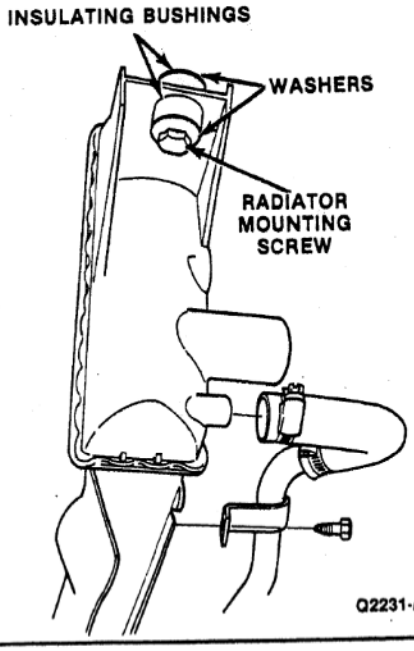
4. On automatic transmission equipped vehicles, disconnect the transmission cooler supply line.
5. Disconnect the cooling fan wiring harness connector and cut the harness routing strap at the connector to free the fan wires.
6. Raise the vehicle and drain the cooling system. On manual transmission equipped vehicles, the drain valve is located in the center of the radiator fill tube, which runs along the bottom of the radiator. On automatic transmission equipped vehicles, the drain valve is at the bottom of the radiator right end tank.
7. On manual transmission equipped vehicles, release the fill tube brackets from the bottom edge of the radiator by removing two screws. Disconnect the fill tube connecting hose from the bottom of the radiator left end tank.



8. Disconnect the radiator lower hose and if equipped, the transmission cooler return line.



9. Remove the screws securing the radiator end tank mounting brackets to the vehicle frame side rails. Note the insulating bushings and washers above and below each bracket. Tip the radiator clear of the upper frame mounting studs and lower it out of the vehicle.

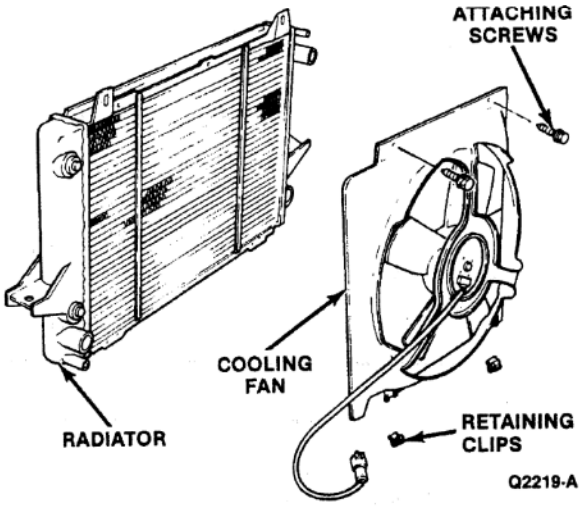


REMOVAL AND INSTALLATION

RADIATOR

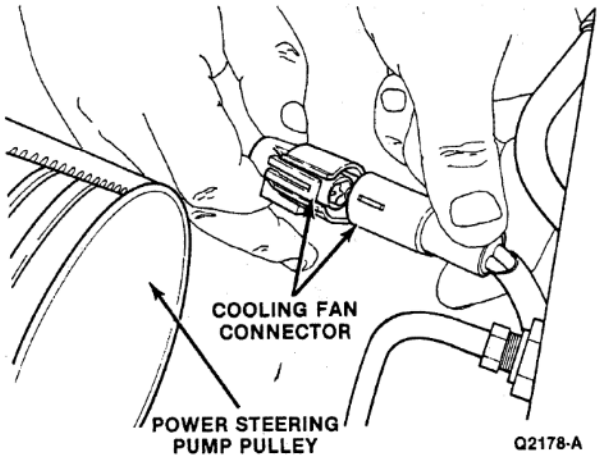
Removal (Continued)

10. If necessary, the electric cooling fan can be removed from the radiator by removing the attaching screws and pulling the fan out of the lower retaining clips.



Installation

1. If necessary, position the fan assembly on the radiator. Secure the top of the fan shroud to the core upper frame with two screws, tightening to 5.0 to 6.5 N·m (44 to 58 lb-in.).
2. Be sure the insulating bushings are in position on the radiator studs in the engine compartment front panel. Position the radiator from below, engaging the core upper frame with the studs, and install washers and nuts finger-tight.
3. Install the radiator mounting screws from below, through the end tank mounting brackets into the vehicle frame side rails (through spacer blocks in automatic transmission vehicles). Position insulating bushings and washers both above and below the brackets as the screws are installed. Tighten the screws to 20.5 to 25.5 N·m (15 to 19 lb-ft).
4. Connect the radiator lower hose and, if equipped, the transmission cooler return line.
5. On manual transmission equipped vehicles, connect the fill tube connecting hose. Secure the fill tube brackets to the core lower frame with two sheet metal screws, tightening to 5.0 to 6.5 N·m (44 to 58 lb-in.).
6. Close the radiator drain.
7. Lower the vehicle and tighten the nuts on the radiator upper support studs to 8 to 12 N·m (6 to 9 lb-ft).
8. Connect the automatic transmission oil cooler supply line, if equipped.
9. Connect the cooling fan harness connector and install a new harness routing strap at the connector.



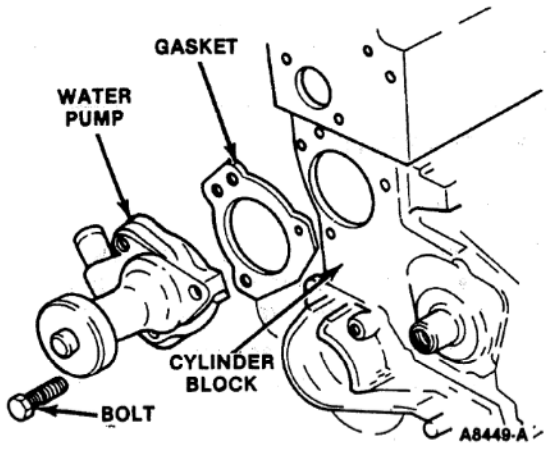
10. Connect the radiator upper hose. On manual transmission equipped vehicles, connect the radiator vent hose.
11. Fill the system with coolant, and install the pressure cap. Warm up the engine to pressurize the system and check for leaks. If necessary, refer to Section 27-01 for refill and test procedures.

REMOVAL AND INSTALLATION

WATER PUMP

Removal

1. Remove the pressure cap and drain the system. Observe precautions in removing the cap if the system is warm and pressurized.
2. Release drive belt tension and disengage the belts. If necessary, refer to Section 27-02.
3. Remove four screws securing the pump pulley to the pump drive flange, and remove the pulley.
4. Disconnect the radiator lower hose from the water pump inlet. If necessary, disengage the A/C compressor belt and swing the compressor away for access to the inlet hose. Also, disconnect the heater bypass return line hose from the pump.
5. Remove the timing belt cover for access to the pump inboard mounting screw. If necessary, refer to Section 21-05 for cover removal.
6. Remove three bolts securing the pump to the front of the block, and remove the pump.



Installation

1. Scrape all traces of the old gasket from the mounting surfaces of pump and block. Coat a new gasket with Water Resistant Sealer B5A-19554-A, or equivalent, and place in position on the block, aligning the pump bolt holes.
2. Carefully position the pump to align the bolt holes without shifting the gasket and install the three pump mounting bolts, tightening to 19 to 28 N·m (14 to 21 lb-ft).
3. Install the timing belt cover. If necessary, refer to Section 21-05 for cover installation.
4. Connect the radiator lower hose and the bypass line return hose to the water pump inlet, tightening the hose clamps to 2.5 to 3.5 N·m (21 to 31 lb-in.)
5. Install the drive pulley on the water pump shaft flange with four screws, tightening to 17 to 25 N·m (13 to 19 lb-ft).
6. Engage the drive belts with crankshaft, water pump, alternator and power steering pump pulleys and adjust belt tension. If necessary, refer to Section 27-02 for belt tensioning.
7. Close the drain valve in the radiator fill tube or right end tank, fill the system with coolant and install the pressure cap. Warm up the engine to pressurize the system and check for leaks. If necessary, refer to Section 27-01 for refill and test procedures.

THERMOSTAT

Removal

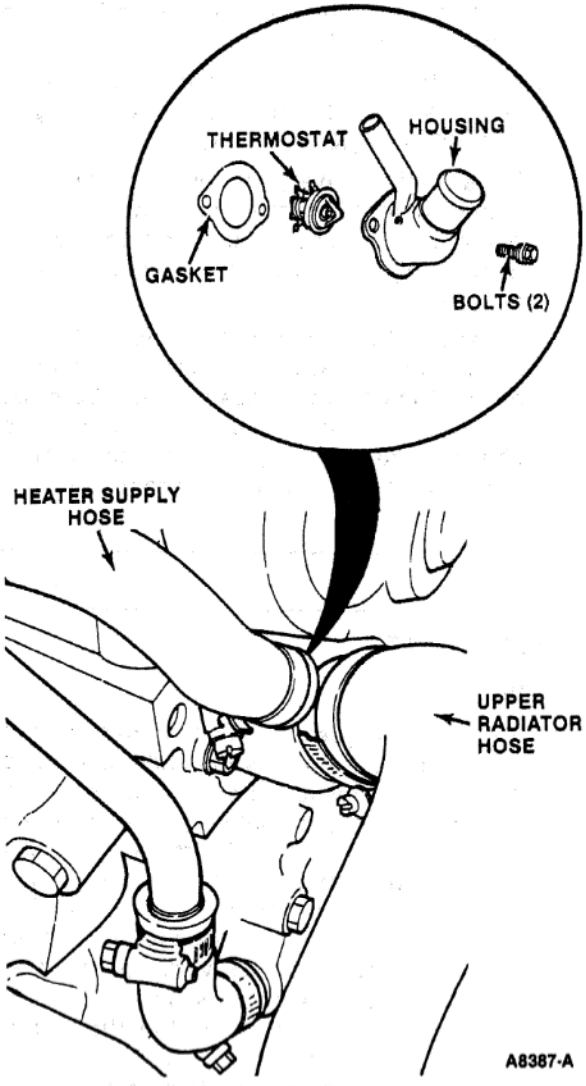
1. Remove the pressure cap, observing precautions if system is warm and pressurized, to release pressure before fully opening. Partially drain the cooling system by opening the drain valve in the radiator fill tube (manual transmission) or right end tank (automatic transmission). While draining, repeatedly pinch the bypass line return hose, connected to the water pump inlet, until it noticeably softens, indicating that the coolant level is below the thermostat housing. Close the drain valve.

REMOVAL AND INSTALLATION

THERMOSTAT

Removal (Continued)

2. Disconnect the radiator upper hose and the heater bypass line connecting hose from the thermostat housing.
3. Remove two screws securing the thermostat housing to the head, and remove the housing.
4. Rotate the thermostat counterclockwise in the housing until free and remove it.
5. If necessary, refer to Section 27-01 for thermostat test procedure.



Installation

1. Scrape all traces of the old gasket from the mounting surfaces on cylinder head and thermostat housing.
2. Install the thermostat in the housing valve-end-first and rotate clockwise to lock in position.

NOTE: When the thermostat is properly installed, the full width of the heater bypass outlet port will be visible in the housing. If the thermostat is installed improperly, partially blocking the port, coolant flow to the heater and oil cooler will be impaired.

3. Coat a new housing gasket with Water Resistant Sealer B5A-19554-A, or equivalent, and position it on the cylinder head with the mounting screw holes correctly aligned.
4. Carefully position the thermostat housing to align the screw holes without shifting the gasket, and install the two mounting screws. Tighten to 19 to 28 N·m (14 to 21 lb-ft).
5. Connect the radiator upper hose and the heater supply hose to the thermostat housing, and tighten the hose clamps to 2.5 to 3.5 N·m (21 to 31 lb-in.).
6. Fill the system with coolant and install the pressure cap. Warm up the engine to pressurize the system and check for leaks. If necessary, refer to Section 27-01 for refill and test procedures.

HEATER VALVE

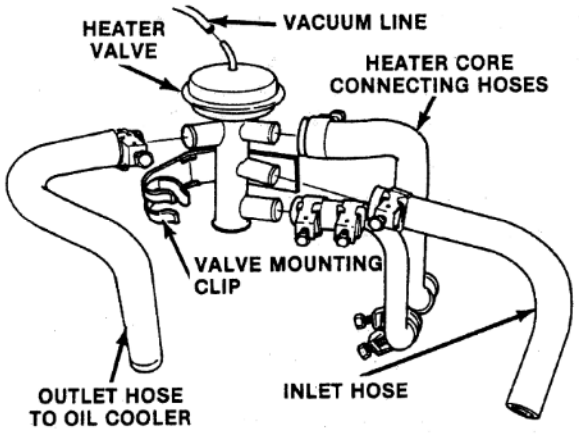
Removal

1. Remove the pressure cap, observing precautions if system is warm and pressurized, to release pressure before fully opening.
2. Disconnect the vacuum line at the top of the heater valve body to allow the valve to open fully, venting the heater core for drainage.

REMOVAL AND INSTALLATION

HEATER VALVE (Continued)

3. Partially drain the cooling system by opening the drain valve in the radiator fill tube or right end tank. Drain until pinching the bypass line return hose at the water pump inlet indicates coolant has dropped below this level. Close the drain valve.
4. Disconnect the inlet hose and the oil cooler outlet hose from the heater valve. Also, disconnect the heater core connecting hoses at the valve.
5. With hoses free, twist the heater valve body out of its mounting clip on the bulkhead just to the left of the battery box.



Installation

1. Snap the heater valve into the spring mounting clip with the upper and lower hose nipples aligned with the heater core connecting hoses. Connect the hoses, tightening the hose clamps to 2.5 to 3.5 N·m (21 to 31 lb-in.).
2. Connect the inlet hose to the center hose nipple between the heater core connections and connect the oil cooler outlet hose to the remaining hose nipple. Tighten the hose clamps to 2.5 to 3.5 N·m (21 to 31 lb-in.).
3. Connect the vacuum hose to the fitting on top of the heater valve.
4. Fill the system with coolant and install the pressure cap. Warm up the engine to pressurize the system and check for leaks. If necessary, refer to Section 27-01 for refill and test procedures.

OIL COOLER

If necessary, refer to Section 21-05 for oil cooler service procedures.

REPAIRS

CLEANING

The aluminum core can be cleaned externally with a soft bristle brush, warm water and a mild household liquid detergent. Then rinse with clear water.

Install steel or brass plugs in the transmission oil cooler fittings before cleaning and keep them installed during the entire service operation.

CAUTION: Do not use caustic cleaning solutions or copper/brass radiator cleaning agents on aluminum radiators. Internal cleaning of the aluminum tubes can only be done with ultrasonic cleaning equipment.

REPAIRS

LEAK TESTING

Clean the radiator before leak testing to prevent contaminating the test tank. Then, leak test the radiator in **clean** water with 20 psi air pressure. **Do not** leak test an aluminum radiator in the same water in which copper/brass radiators are tested. Flux and caustic cleaners may be present in the tank, and they will attack aluminum. A separate clean test tank is recommended for aluminum radiators. If conditions do not allow a separate tank for aluminum radiator leak testing, thoroughly clean the test tank each time before testing an aluminum radiator in the tank.

LEAK REPAIR

End Tank Leaks

Emergency repairs can be made to the radiator plastic end tanks using Dow Corning 1200 Prime Coat Clear and Dow Corning Silastic 734 RTV. These are self-levelling, single component, silicone rubber materials which set to a durable elastic rubber at ambient temperature and are weather and corrosion resistant.

Apply a thin, even coat of Dow Corning 1200 primer, using a brush. Allow it to dry for 10 minutes at room temperature. Apply Dow Corning "Silastic 734 RTV" in **undiluted** form. Allow it to dry for one hour at room temperature so that a non-adhesive, pressure-resistant surface film can develop.

End Tank Flange Leaks

Re-press the flanges in the leak area using a suitable tool. If the leak persists, apply a thin, even coat of Dow Corning 1200 primer using a brush. Extend the area of application by at least 50 mm (2 in.) on each side of the leak area. Allow to dry for 10 minutes at room temperature. Apply diluted silicone rubber (55 percent. Silastic 734 RTV, 45 percent Perchlorethylene by weight, mixed thoroughly) with suitable tool (spatula, etc.). Position the radiator so as to prevent cement from running off repair area. Leave to dry for 30 minutes at room temperature so that a non-adhesive, pressure-resistant surface film can develop. The setting process takes 24 hours.

Transmission Oil Cooler Connection Leaks

Check to see that the fitting nut is fully tightened. If the leak persists, apply a thin, even coat of Dow Corning 1200 primer using a brush. Allow to dry for 10 minutes at room temperature. Apply Dow Corning "Silastic 734 RTV" in **undiluted** form around the leaking connection and allow it to dry for one hour.

Radiator Core Leaks (Aluminum Core Only)

The only approved service method for the aluminum radiator core is using a two-component epoxy material. The materials and supplies necessary to service the aluminum core are:

- EPOXI-PATCH Kit No. 6 Aluminum. Hysol Division of the Dexter Corporation, Olean, New York 14760
- Sandpaper and/or emery paper—80 or 100 grit
- Stainless steel wire brush No. 23151. The Milwaukee Brush Manufacturing Company, Menominee Falls, Wisconsin 53051
- 375 watt heat lamp
- Methylene chloride solvent
- Mixing card and spatulas

1. Mark the leak(s) and dry the core with compressed air in area of leak(s).
2. If the leak is in the fin area of the core, spread the fins away from the leak before cleaning the area.
3. Clean area around the leak with 80 or 100 grit sandpaper or emery cloth and/or with a small stainless steel wire brush. Do not use wire brushes that are not stainless steel.
4. Squeeze a bead (length) of resin Part A on a clean, dry, disposable flat mixing surface. Use uniform pressure to obtain an even bead.

NOTE: Observe all cautions and warnings printed on the service material containers.

5. Squeeze an equal length bead of hardener (Part B) parallel to the Part A bead.
6. Mix Parts A and B together.

REPAIRS

LEAK REPAIR

7. Clean the area around the leak with methylene chloride.
8. Warm the core around the leak with a 375 watt heat lamp. Then, apply the material to the leak.
9. Position the 375 watt heat lamp 12 inches from the area and allow to cure for two hours. Do not position the heat lamp closer to the service area than 12 inches. Do not use a heat gun or overheat the material.
10. When the service area is cured, leak test and paint the area (if required).

SECTION 27-10 Engine Cooling Fan

SUBJECT	PAGE
DESCRIPTION	27-10-1
REMOVAL AND INSTALLATION	
Cooling Fan Temperature Switch	27-10-3
Engine Cooling Fan and A/C Fan Relays	27-10-3
REMOVAL AND INSTALLATION (Cont'd.)	
Engine Cooling Fan and Shroud Assembly	27-10-2
Engine Cooling Fan Motor	27-10-2

DESCRIPTION

The electric engine cooling fan is mounted on the left side of the radiator core in the engine compartment. An electric A/C fan is mounted on the right side of the A/C condenser which is mounted directly in front of the radiator. The offset arrangement of the fans sets up a "push-pull" air flow over the radiator core fins. When the A/C fan is operating, air is "pushed" through and over the radiator core cooling fins. When the engine cooling fan is operating, air is "pulled" through the radiator. This dual fan arrangement allows cooling requirements to be tailored to heat loads generated by the engine and air-conditioning systems.

The fans will operate separately or in tandem depending on engine coolant temperature, A/C usage and A/C high side pressure.

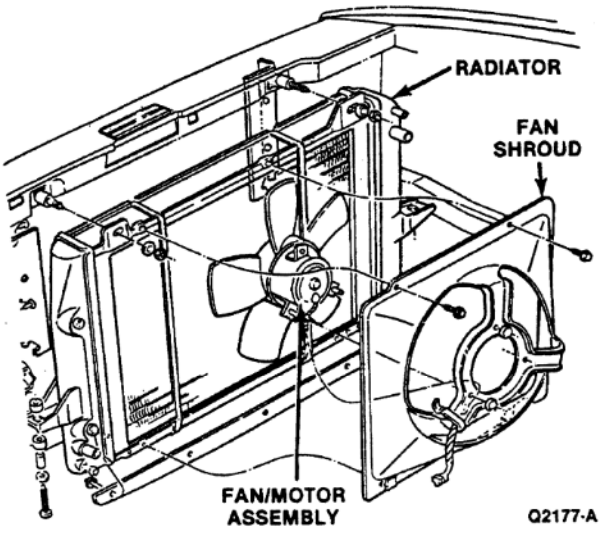
The engine cooling fan will operate under two conditions:

- Engine coolant temperature above 210°F
- A/C control switch in the ON position

The A/C fan will operate under two conditions:

- Engine coolant temperature above 210°F
- A/C high side pressure above 254 psi

The engine cooling fan will operate separately whenever the A/C switch is in the ON position. It will continue to operate separately until engine coolant temperature reaches 210°F (±6°), or A/C high-side pressure exceeds 254 psi. If either of these conditions are met, the A/C fan will join the engine fan to reduce the cooling system heat load.

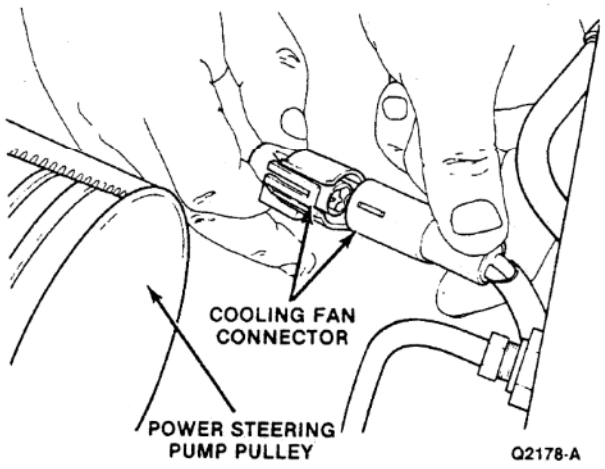


REMOVAL AND INSTALLATION

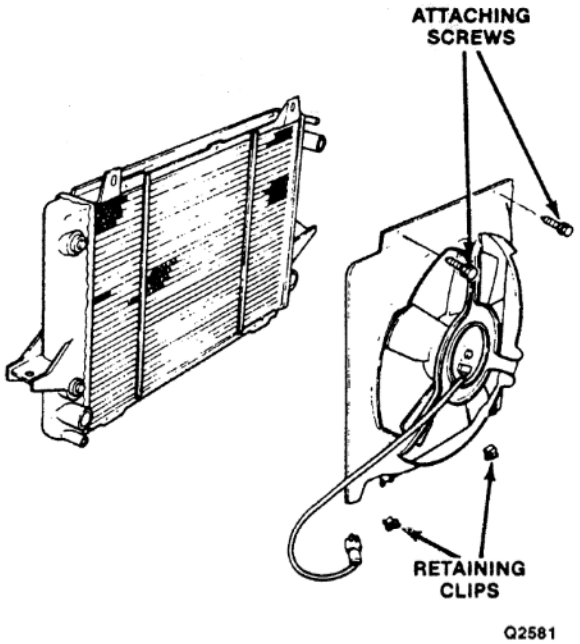
Engine Cooling Fan and Shroud Assembly

Removal

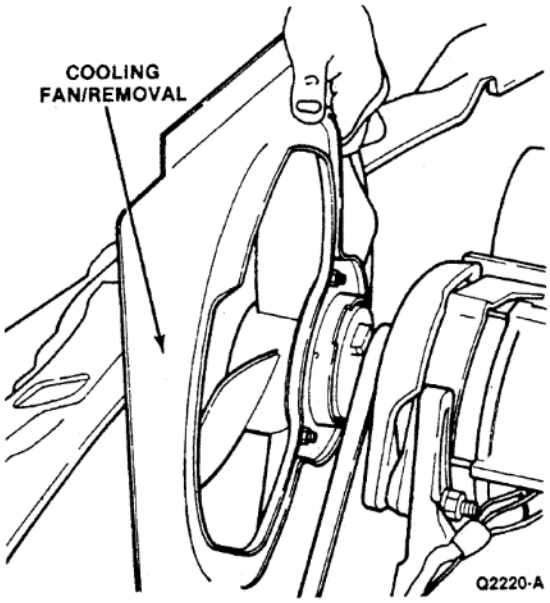
1. Disconnect the battery negative cable.
2. Disconnect the cooling fan wiring connector.



3. Remove the screws attaching the top of the fan shroud to the radiator.



4. Pull straight up on the mounting bracket to release the fan and shroud assembly from the lower attaching clips and remove from the vehicle.

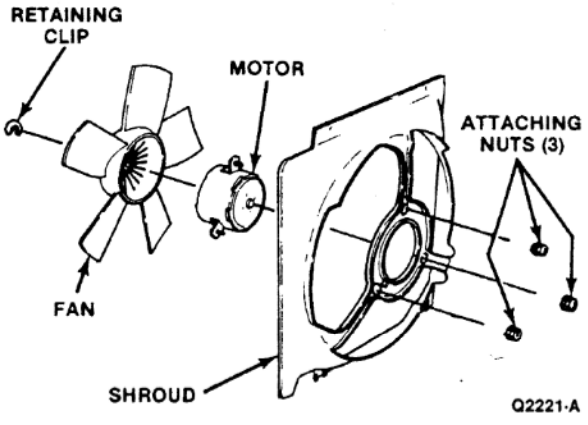


Installation

1. Position the fan and shroud assembly in the vehicle. Make sure the shroud engages the lower attaching clips and that the clip on the left side is between the beads on the shroud.
2. Install the fan shroud attaching screws.
3. Connect the cooling fan wiring connector.
4. Connect the battery negative cable.

Engine Cooling Fan Motor

Removal



1. Remove the cooling fan and shroud assembly. If necessary, refer to the procedure in this Section.

REMOVAL AND INSTALLATION (Continued)

2. Remove the cooling fan attaching nuts and remove the fan shroud.
3. Remove the clip attaching the fan to the motor shaft. Remove the fan.

Installation

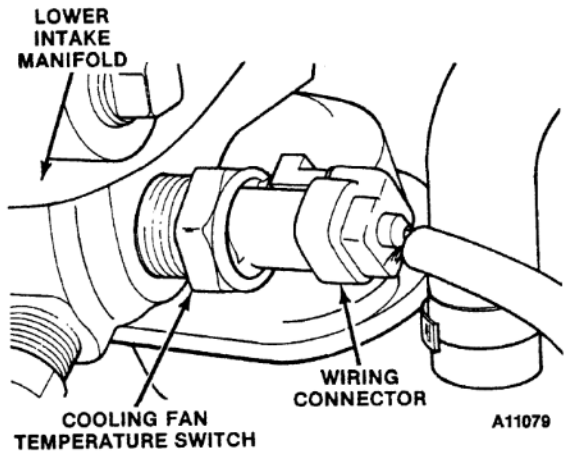
1. Position the fan on the motor shaft and install the retaining clip.
2. Position the motor on the fan shroud and install the attaching nuts.
3. Install the cooling fan and shroud assembly. If necessary, refer to the procedure in this Section.

Cooling Fan Temperature Switch

Removal

NOTE: The cooling fan temperature switch is threaded into the back of the lower intake manifold.

1. Disconnect the wiring connector at the temperature switch.
2. Position a drain pan under the vehicle below the switch.
3. Remove the switch.



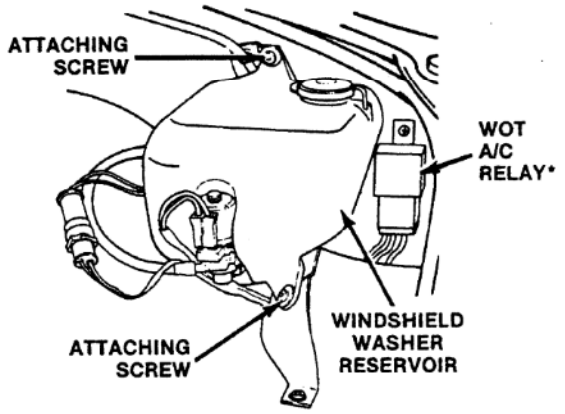
Installation

1. Wrap the switch threads with teflon tape.
2. Install the switch.
3. Connect the wiring connector.
4. Fill the cooling system to the proper level. If necessary, refer to Section 27-03.

Engine Cooling Fan and A/C Fan Relays

Removal

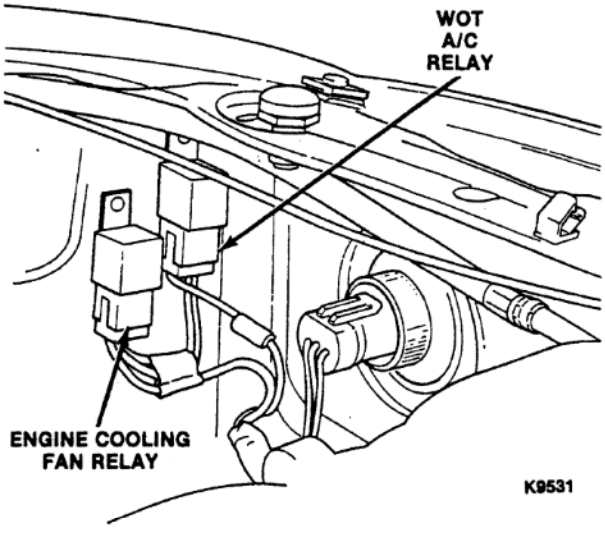
1. The engine cooling fan and A/C fan relays are located in the left front corner of the engine compartment, near the washer solvent bottle. To replace a relay, the two phillips head screws, holding the solvent bottle must be removed, and the bottle positioned rearward.



* NOTE—LOCATED ON RIGHT FENDER APRON ON EARLY 1985 MODEL VEHICLES

K9530

2. With the solvent bottle moved, the two relays can be removed, using a phillips screwdriver.



K9531

GROUP 27 SPECIFICATIONS

COOLING SYSTEM DESIGN:
- Heat exchanger radiator with electric cooling fan
- Expansion tank and coolant recovery bottle
- Pressure cap located on expansion tank
- Vacuum actuated valve controls coolant flow through heater core
- Engine oil cooler mounted between cylinder block and oil filter
- Engine coolant flows through turbocharger to aid in cooling bearings

RADIATOR DESIGN:
- Crossflow, tube and fin
- Plastic end tanks
- Core material—Copper brass (manual transmission)
  Aluminum (automatic transmission)

COOLING SYSTEM CAPACITY: 9.0 liters/9.5 gallons

THERMOSTAT: Bypass type
Start to open at 89°C (192°F)
Fully open at 100°C (212°F)

WATER PUMP: Centrifugal vane, belt driven

TORQUE SPECIFICATIONS

Item	N·m	lb-ft
Fan shroud to radiator core frame	5.0–6.5	44–58*
Radiator lower mounting to frame rail	20.5–25.5	15–19
Fill tube to radiator core frame	5.0–6.5	44–58*
Radiator upper mounting to studs	8–12	6–9
Water pump to cylinder block	19–28	14–21
Water pump pulley to flange	17–25	13–19
Thermostat housing to block	19–28	14–21

*Inch-pounds

STARTING SYSTEM

GROUP 28 (11000)

TITLE SECTION	PAGE NO.	TITLE SECTION	PAGE NO.

STARTER MOTOR DIAGNOSIS 28-01

DESCRIPTION 1

TROUBLESHOOTING CHART—
STARTER MOTOR 2

DIAGNOSTIC PROCEDURES

Current Draw Test 3
Voltage Drop Tests 4
Starter Relay Test 8
Starter Relay Pull In Winding Test 9

STARTER MOTOR 28-02

DESCRIPTION 1

JUMP STARTING 3

REMOVAL AND INSTALLATION

Starter Motor 4
Starter Drive Gear 4
Starter Relay 7

DISASSEMBLY AND ASSEMBLY

Starter Motor Disassembly 8
Component Test and Inspection
Chart—Starter Motor 11
Subassembly Replacement 15
Starter Motor Assembly 21

GROUP 28

SPECIFICATIONS 1

SECTION 28-01 STARTER MOTOR DIAGNOSIS

CONTENTS

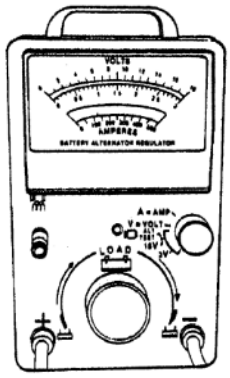
Page

DESCRIPTION 1

TROUBLESHOOTING CHART—
STARTER MOTOR 2

DIAGNOSTIC PROCEDURES

Current Draw Test 3
Voltage Drop Tests 4
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Starter Relay Pull In Winding Test 9

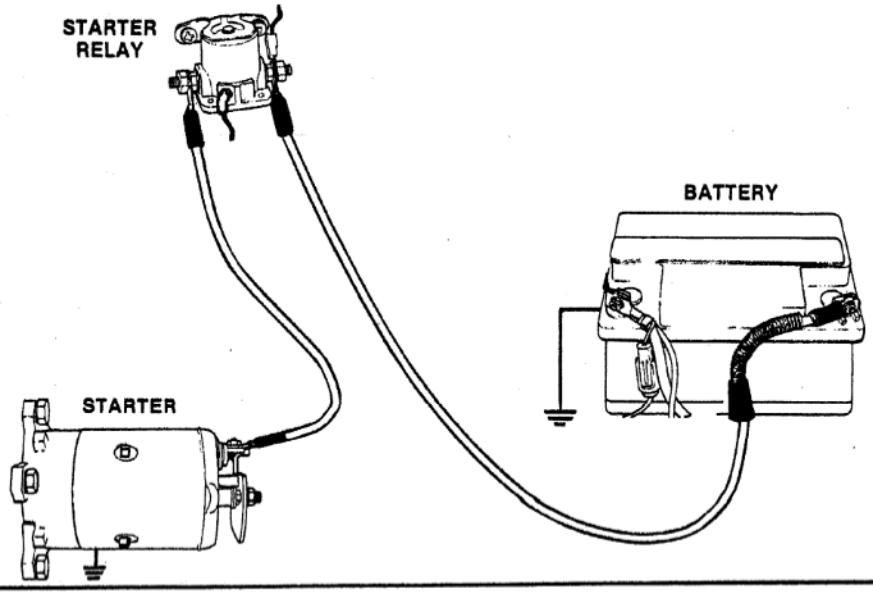


J4000-A

DESCRIPTION

The function of the starting system is to crank the engine at a speed fast enough to permit the engine to start. Heavy cables, connectors, and switches are used in the starting system because of the large amount of current required by the starter while it is cranking the engine. The amount of resistance in the starting circuit must be kept to an absolute minimum to provide maximum current for starter operation. Loose or corroded connections, relay contacts, or partially broken cables will result in slower-than-normal cranking speeds and may even prevent the starter from cranking the engine.

If the starter motor or circuit are suspected of causing a no-start condition, use the following diagnostic chart and the appropriate tests to isolate the problem.



J3005-A

STARTER MOTOR TROUBLESHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine cranks slowly.	1. Undercharged battery.	1. Check battery. Charge or replace. If necessary, refer to Section 31-01.
	2. Loose connections or corroded battery cables	2. Clean and tighten cable connections. If necessary, refer to Section 31-01.
	3. Starter motor.	3. Refer to the starter current draw test in this section.
Engine will not crank—starter relay clicks.	1. Undercharged battery.	1. Check battery. Charge or replace. If necessary, refer to Section 31-01.
	2. Loose cable connections at relay or starter.	2. Clean and tighten cable connections—check wire strands in eyelets. Refer to the voltage drop tests in this section.
	3. Starter motor.	3. Repair or replace as required. Refer to the starter current draw test in this section.
Engine will not crank—starter relay chatters or does not click.	1. Undercharged battery.	1. Check battery. Charge or replace. If necessary, refer to Section 31-01.
	2. Loose cable connections or corroded battery cables.	2. Clean and tighten cable connections. Refer to the voltage drop tests in this section.
	3. Starter relay circuit.	3. Refer to the starter relay tests in this section.
Engine will not crank—starter spins.	1. Starter motor.	1. Remove starter and inspect drive. Replace as required.
	2. Flywheel ring gear.	2. Remove starter and inspect ring gear teeth (also starter drive pinions). Replace as required.
Engine cranks continuously with key off.	1. Starter relay.	1. Replace starter relay. If necessary, refer to Section 28-02.

CJ2984-A

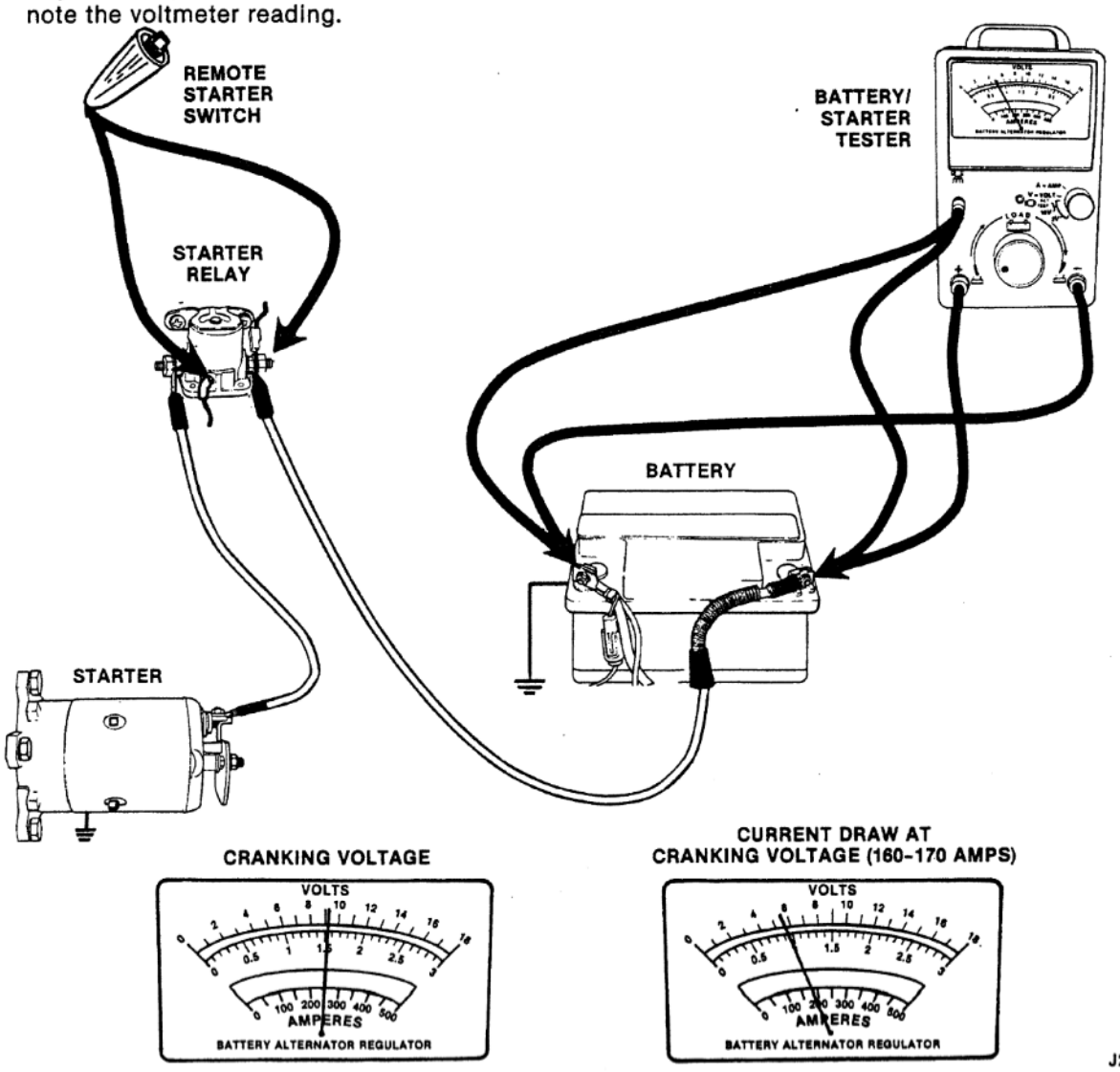
DIAGNOSTIC PROCEDURES

CURRENT DRAW TEST

1. The battery must be fully charged and in good condition prior to performing a starter motor current draw test. If necessary, refer to Section 31-01 for battery and charging system diagnosis.
2. Disconnect and ground the ignition coil secondary wire.
3. Connect a remote starter switch between the starter relay S-terminal and the battery positive terminal.
4. Connect a battery-starter tester. Crank the engine, using the remote starter switch and note the voltmeter reading.

NOTE: Do not operate the starter for more than 15 seconds to prevent overheating of the motor.

5. With the remote starter switch off, rotate the carbon pile knob on the battery-starter tester clockwise until the voltmeter reading is the same as in Step 4.
6. Read the starter current draw on the ammeter. The current draw must be between 150 to 250 amperes of room temperature. If current draw is not within specifications, refer to Section 28-02 for disassembly and component testing.



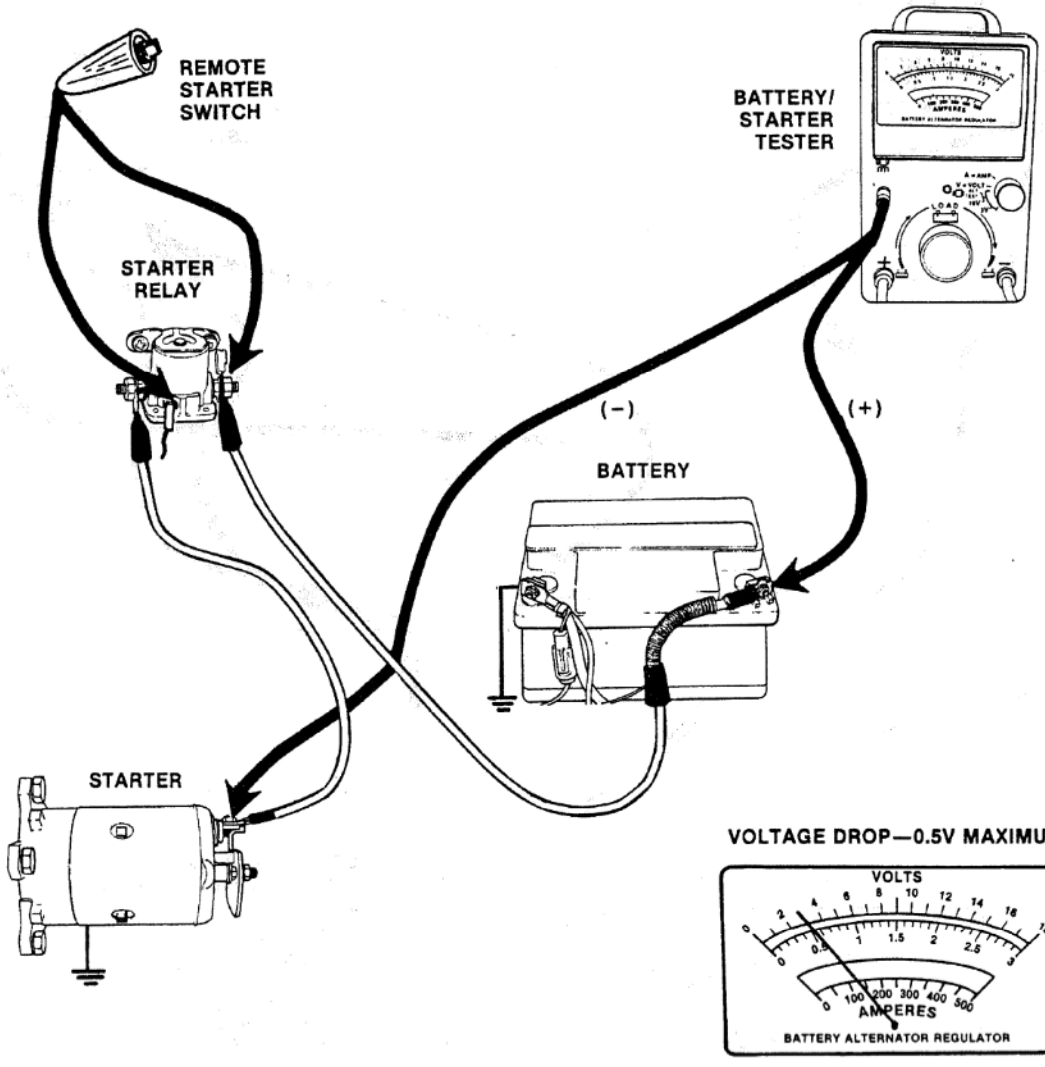
DIAGNOSTIC PROCEDURES

VOLTAGE DROP TESTS

Test 1

These tests are performed to determine if there is excessive resistance in the starter motor circuit. Always make the voltmeter connections at the component wiring terminal rather than the cable or wiring terminal. Making a connection at the wiring terminal could result in false readings because the meter will not pick up a high resistance between the wiring connector and the component.

1. Disconnect and ground the coil secondary wire.
2. Connect a remote starter switch between the starter relay S-terminal and the battery positive terminal.
3. Connect the voltmeter positive lead to the battery positive post. Connect the voltmeter negative lead to the starter terminal.
4. Crank the engine and read the voltmeter. The voltmeter reading should be 0.5 volts or less. If the voltage drop is higher, move the voltmeter negative lead to the cable terminal at the starter. Retest for voltage drop. If voltage drop is now less than 0.5 volts, clean the cable connection at the starter motor. If voltage drop is still high, perform Test 2.

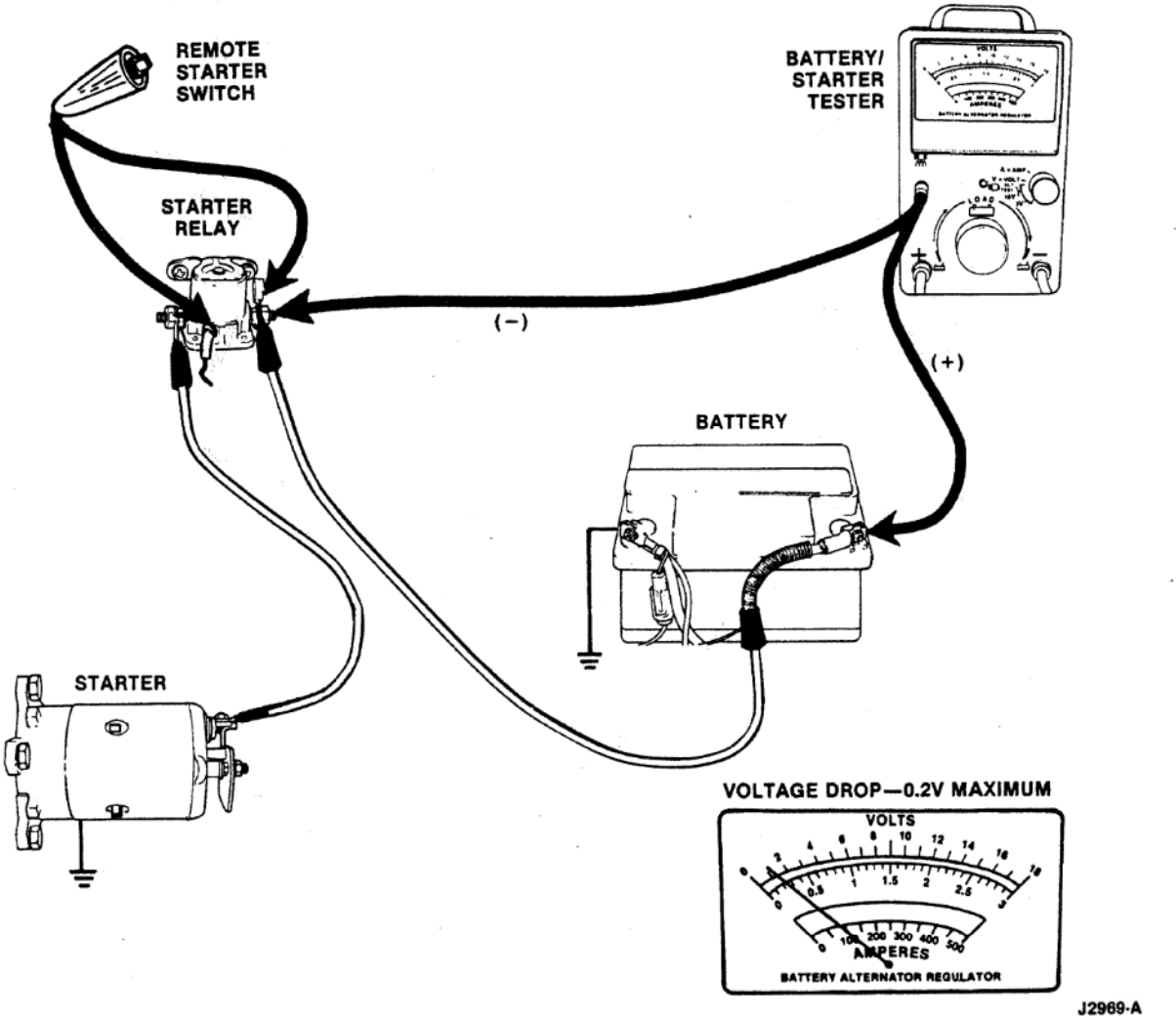


DIAGNOSTIC PROCEDURES

VOLTAGE DROP TESTS (Continued)

Test 2

1. Connect the voltmeter positive lead to the battery positive terminal. Connect the voltmeter negative lead to the starter relay battery terminal.
2. Crank the engine and observe the voltmeter. The voltmeter reading should be 0.2 volts or less. If the voltage drop is high, clean the terminal ends. Retest and, if still high, replace the cable.



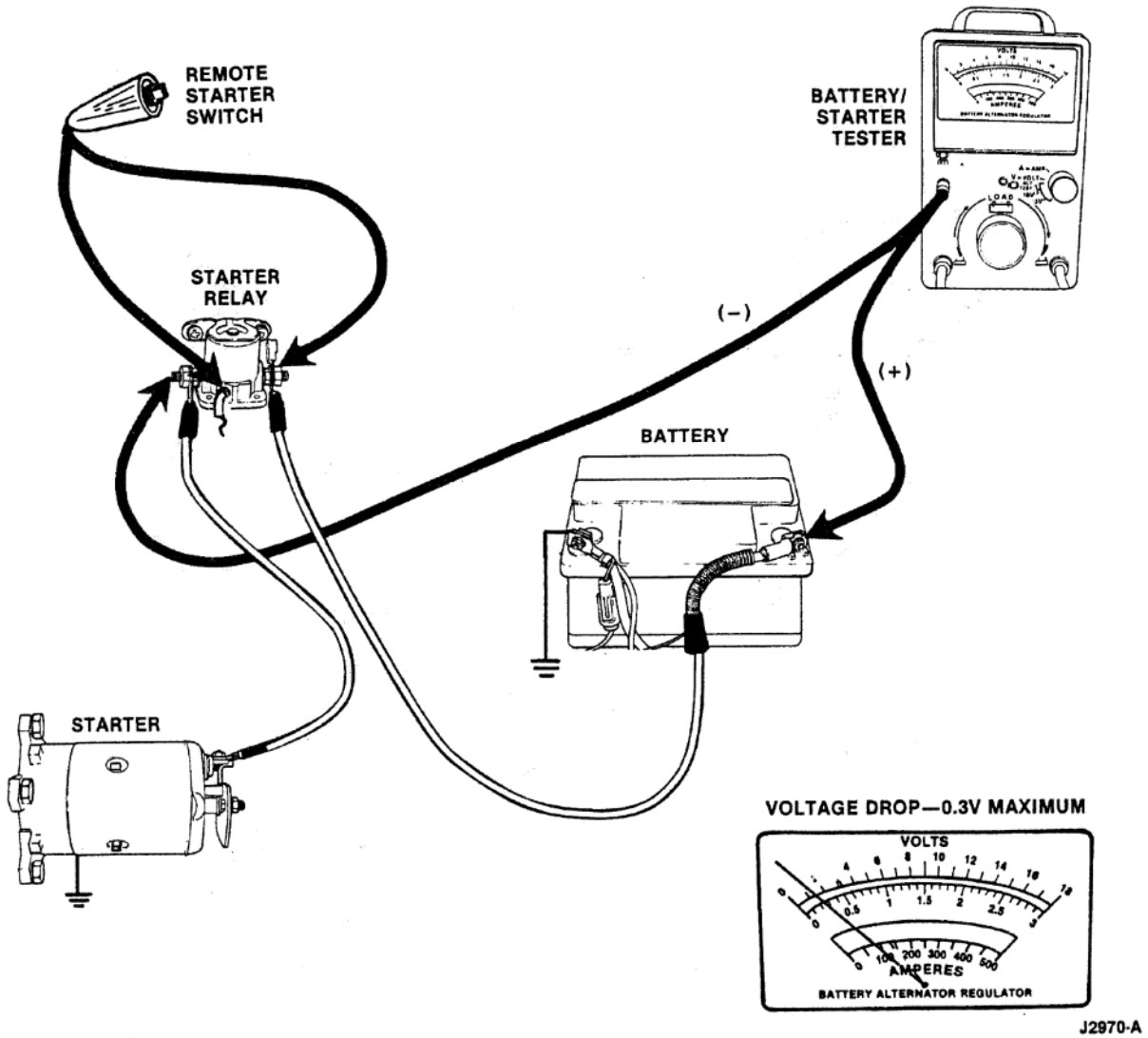
DIAGNOSTIC PROCEDURES

VOLTAGE DROP TESTS (Continued)

Test 3

1. Connect the voltmeter positive lead to the battery positive terminal. Connect the voltmeter negative lead to the starter cable at the starter relay.
2. Crank the engine and observe the voltmeter. The voltmeter reading should be 0.3 volts or less. If voltage drop is higher than 0.3 volts, clean the terminal end and retest. If the voltage drop is still high, replace the starter relay.

NOTE: If the battery-to-starter motor circuit was above 0.5 volts and the voltmeter reading in Step 2 is 0.3 volts or below, replace the starter relay-to-starter motor cable.

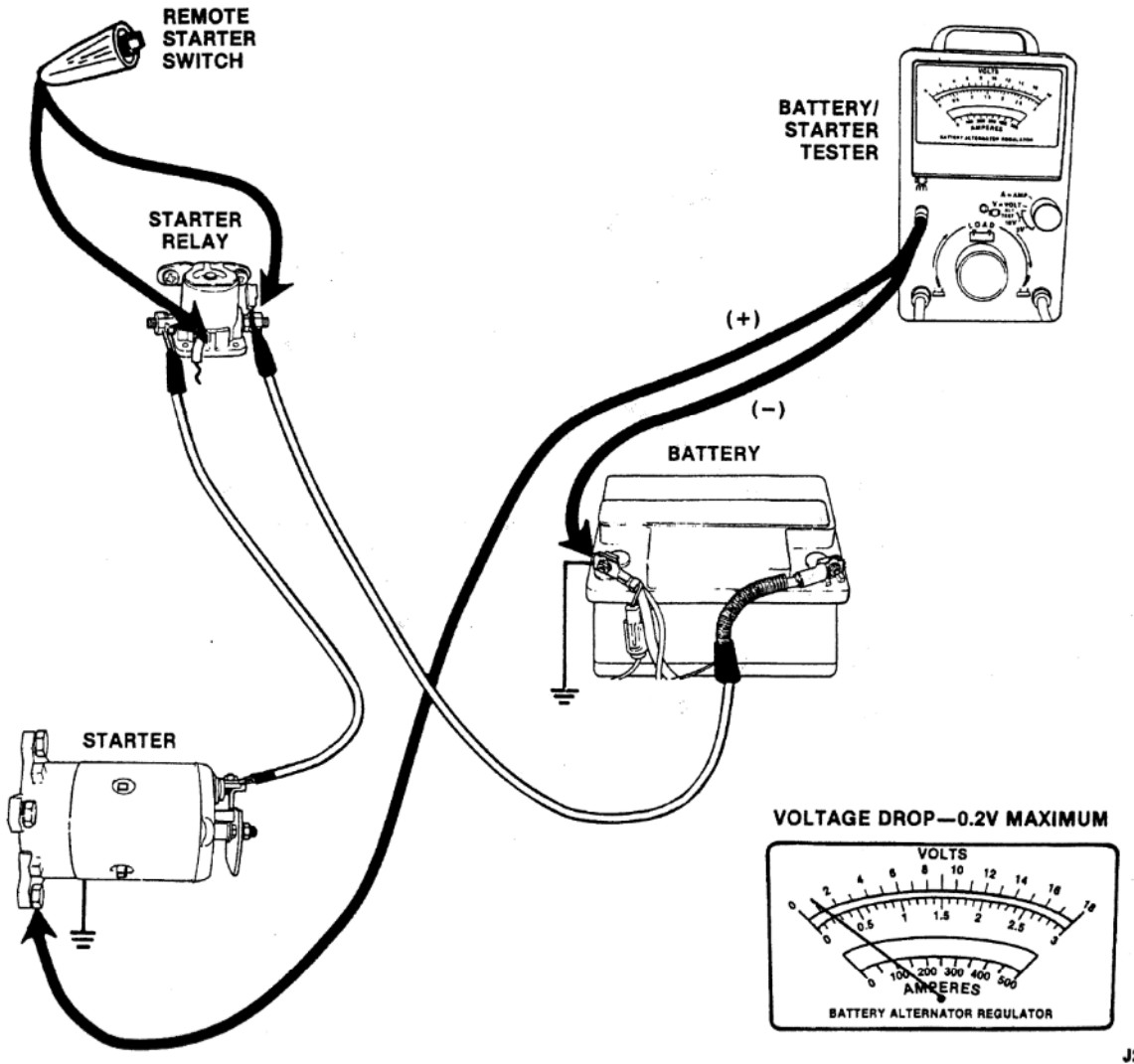


DIAGNOSTIC PROCEDURES

VOLTAGE DROP TESTS (Continued)

Test 4

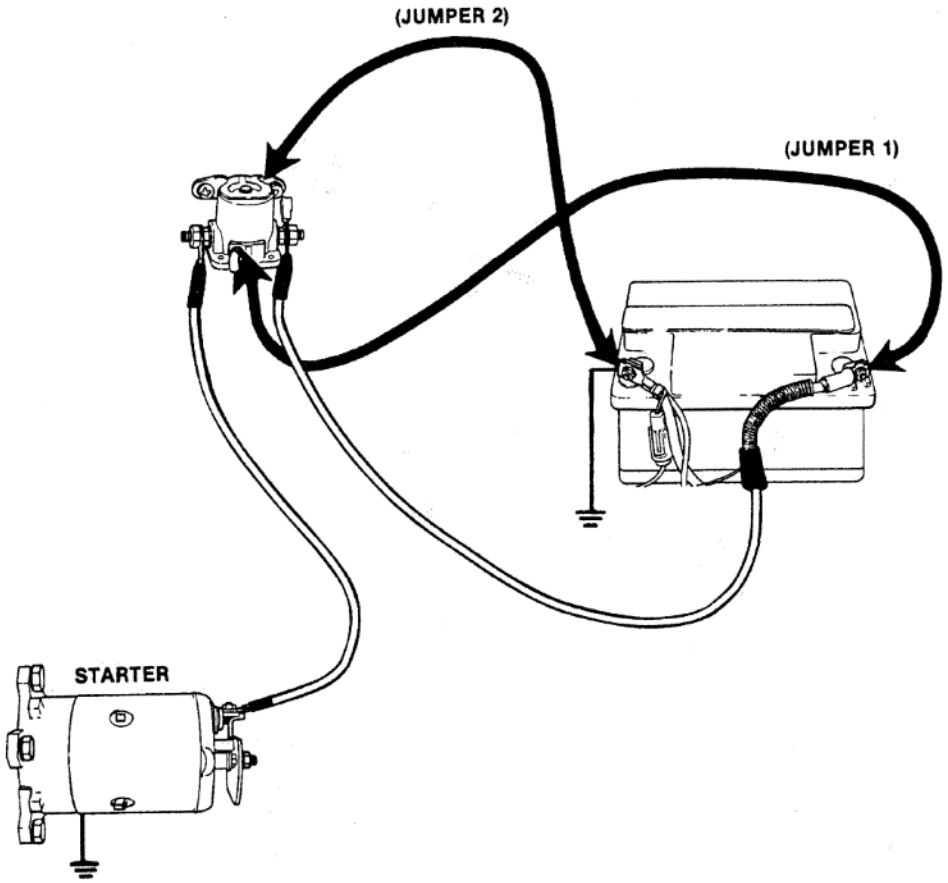
1. Connect the voltmeter positive lead to the starter motor housing. Connect the voltmeter negative lead to battery negative terminal.
2. Crank the engine and observe the voltmeter reading. The voltage drop should be 0.2 volts or less.
3. If the voltage drop is above 0.2 volts, move the voltmeter positive lead to the engine ground cable and retest. If voltage drop is 0.2 volts or less, check the starter mounting bolts for looseness or corrosion.
4. If the voltage drop is still high, clean the negative cable connections at the battery and engine block. Retest voltage drop. If still high, replace the battery negative cable.



DIAGNOSTIC PROCEDURES

STARTER RELAY TEST

1. Disconnect the wiring connector from the starter relay S-terminal and connect a wire from the battery positive post to the solenoid S-terminal. If the engine cranks, the solenoid is OK. Check the neutral safety switch and wiring.
2. If the engine does not crank, connect a jumper wire from the battery negative terminal to the starter relay mounting bracket. If the engine cranks, check the starter relay ground at the mounting bracket or the neutral safety switch and wiring.
3. If the relay clicks but the starter motor does not crank, the problem is probably in the starter motor. If the relay does not click, proceed to the starter relay pull in winding test.

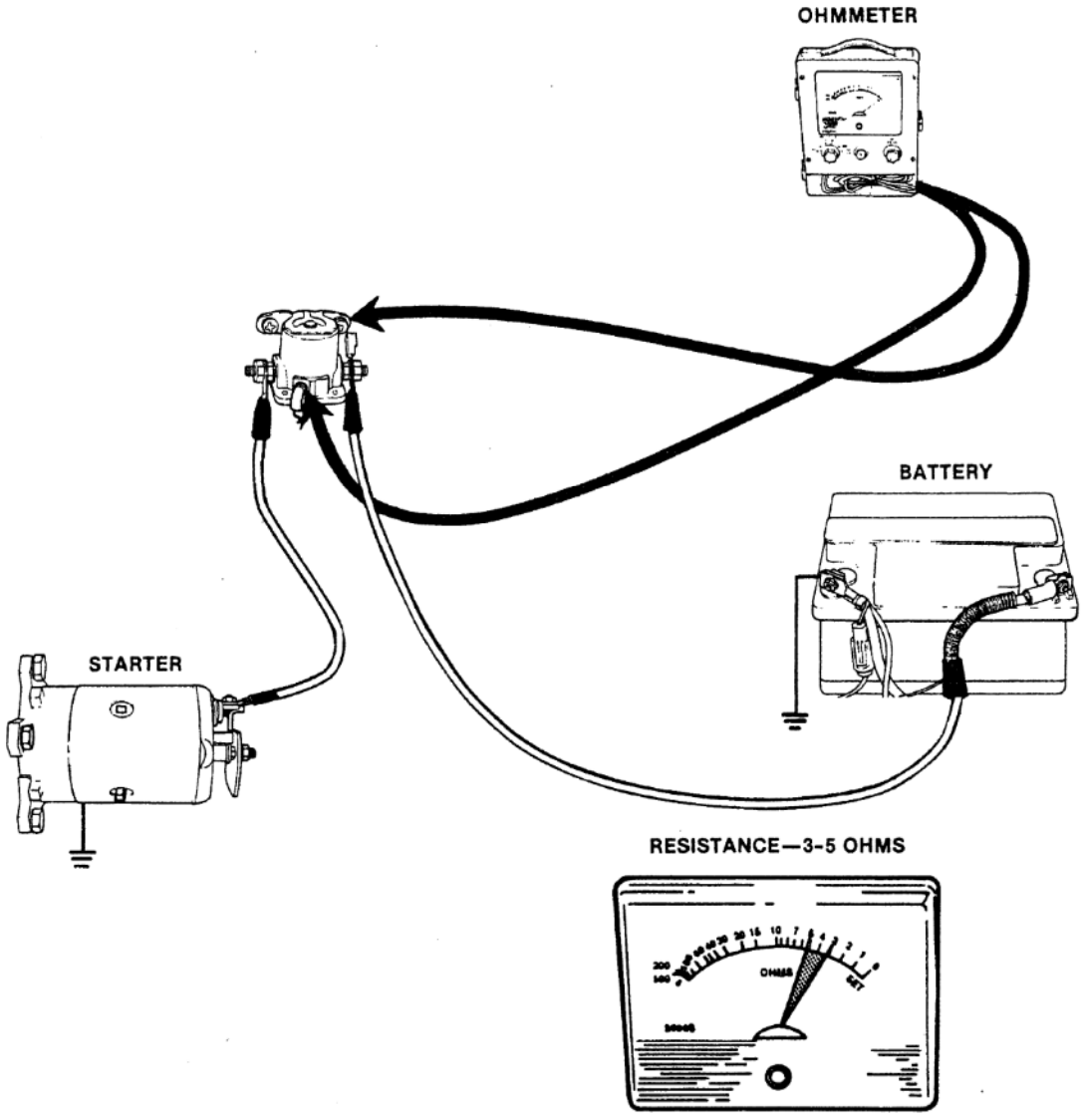


DIAGNOSTIC PROCEDURES

STARTER RELAY PULL IN WINDING TEST

Use this test to check for shorted or open starter relay pull in winding.

1. Remove the wire from the starter relay S-terminal. Connect an ohmmeter lead to the S-terminal. Connect the remaining ohmmeter lead to the starter relay mounting bracket. The ohmmeter should read 3 to 5 ohms.
2. If the starter relay resistance is higher or lower, replace the solenoid.



SECTION 28-02—STARTER MOTOR

CONTENTS

Page

DESCRIPTION 1

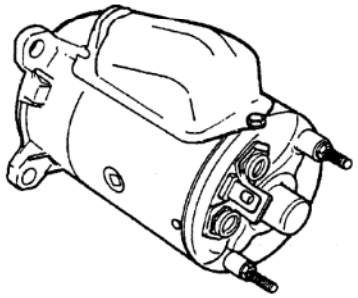
JUMP STARTING 3

REMOVAL AND INSTALLATION

- Starter Motor 4
- Starter Drive Gear 4
- Starter Relay 7

DISASSEMBLY AND ASSEMBLY

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- Component Test and Inspection Chart—Starter Motor 11
- Subassembly Replacement 15
- Starter Motor Assembly 21



J2983-A

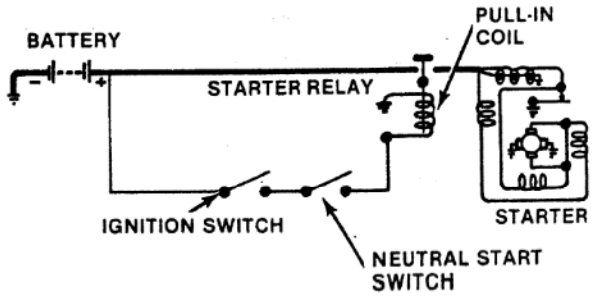
DESCRIPTION

The starter motor is mounted on the lower right side of the engine.

The starter system has two electrical circuits: a low-current circuit and a high-current circuit. The low-current circuit is the control circuit. It includes the ignition switch, starter relay, neutral safety switch and the necessary interconnecting wiring. The high-current circuit connects the starter motor to the battery positive terminal. This circuit uses heavy gauge cables because of the high-current flow required to operate the starter motor.

The starter motor low-current circuit is controlled by the ignition switch. When the ignition switch key is turned to III (START) position, battery current will be applied to the starter relay "S" terminal, if the neutral safety switch contacts are closed. With an automatic transmission equipped vehicle, the gear selector lever must be in PARK or NEUTRAL to close the neutral safety switch contacts. On a manual transmission, the contacts will close only when the gear selector switch is in neutral. The switch is mounted on the left side of the automatic transmission and is operated by internal linkage. The manual transmission switch is mounted on the transmission extension housing and is operated by the gearshift lever.

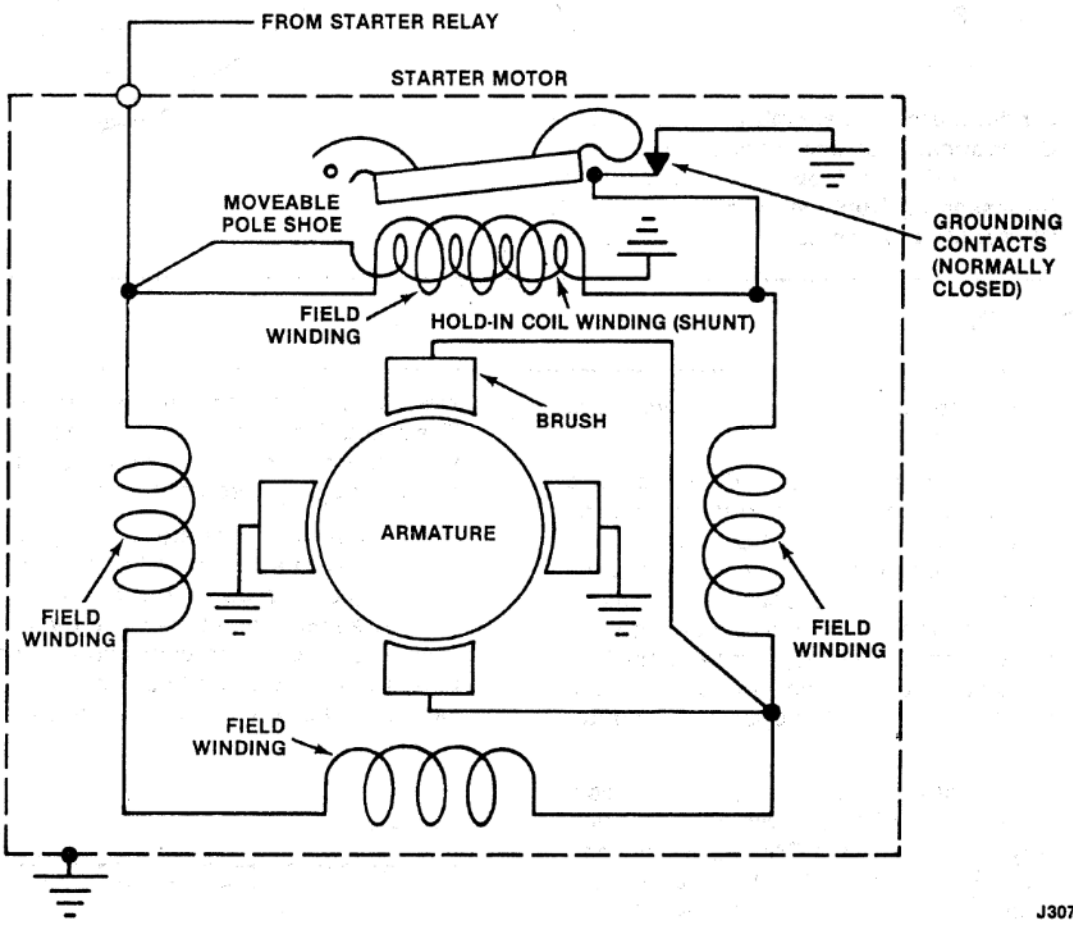
Battery current at the starter relay "S" terminal flows through a pull-in coil to ground. The magnetic force created by the coil pulls the relay armature and contact disc into the closed position. The disc mates with two contacts in the relay to complete the heavy current circuit between the battery and starter motor.



J3072-A

DESCRIPTION

When the starter circuit is first closed, heavy current flows from the battery through the grounded field coil. The magnetic force created by this current flow pulls the moveable pole shoe downward into the starter frame. The pole shoe is attached to the starter drive gear through a yoke and when it moves downward it moves the drive gear into engagement with the ring gear. When the moveable pole shoe is fully seated, it opens the field coil grounding contacts and the starter armature begins to rotate. After the points are opened, a smaller hold-in coil creates the magnetic force needed to hold the moveable poleshoe in position.



JUMP STARTING

WARNING: To avoid any possibility of injury, use particular care when connecting a booster battery to a discharged battery.

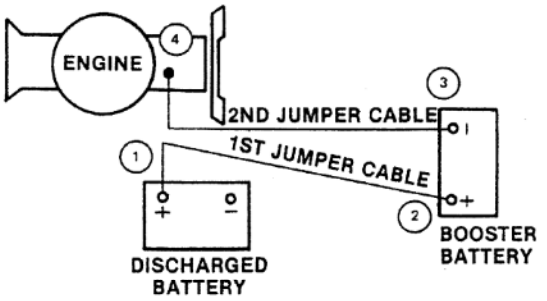
On road service calls, connect a 12 volt booster battery when the starter will not crank the engine or cranks the engine very slowly.

To avoid damage to the vehicle and battery or the possibility of personal injury, follow these instructions and precautions:

CAUTION: Hydrogen and oxygen gases are produced during normal battery operation. This gas mixture can explode if flames, sparks or lighted tobacco are brought near the battery. When charging or using a battery in an enclosed space, always provide ventilation and shield your eyes.

Keep out of reach of children. Batteries contain sulfuric acid. Avoid contact with skin, eyes or clothing. Also, shield your eyes when working near the battery to protect against possible splashing of the acid solution. In case of acid contact with skin, eyes or clothing, flush immediately with water for a minimum of fifteen minutes. If acid is swallowed, drink large quantities of milk or water, followed by milk of magnesia, a beaten egg, or vegetable oil. Call a physician immediately.

MAKE CONNECTIONS IN NUMERICAL ORDER (DISCONNECT IN REVERSE ORDER 4, 3, 2, 1).



MAKE SURE VEHICLES DO NOT TOUCH

J3023-A

1. Position the vehicle so that the jumper cables will reach, being careful that the vehicles **do not touch.**
2. Make sure all lamps are turned off before and during jump start.
3. Turn on heater blower motor to remove voltage transients.
4. Shield eyes, using safety goggles, or similar eye protection.
5. Make the jumper cable connections as follows:
   - Connect one end of the first jumper cable to the positive (+) terminal of the discharged battery and the other end to the positive (+) terminal of the booster battery.
   - Connect one end of the second jumper cable to the negative (−) terminal of the booster battery and then the other end to a good metallic contact spot **on the engine** of the vehicle to be started, **not to the negative (−) battery terminal.**

WARNING: Making the final cable connection could cause an electrical arc which is made near the battery and could cause an explosion. Refer to CAUTION at the beginning of the jump-starting procedure.

- Make sure the jumper cables are not in the way of moving engine parts.
- Start the engine of the vehicle with the good battery and run the engine at a moderate speed.
- Start the engine of the vehicle with the discharged battery. Follow starting instructions in the Owner's Guide.

WARNING: Do not disconnect the battery of the vehicle to be started. Disconnecting the battery could damage the vehicle's electrical system.

- Leave all electrical components off and reduce engine speed to idle on both vehicles to prevent possible damage to the vehicle electrical system.

JUMP STARTING

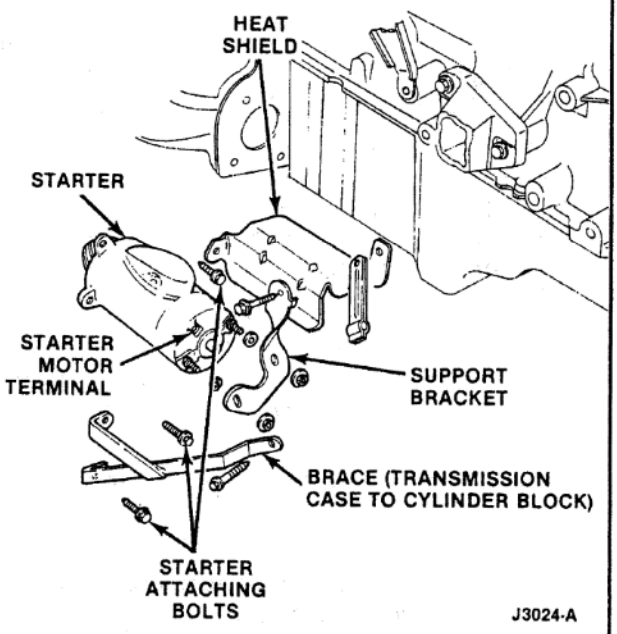
6. Remove cables in the exact reverse sequence. Begin by removing the cable from the engine of the vehicle that had the discharged battery. With the jumper cables disconnected, the vehicle electrical components can be used.

If the starter does not crank the engine sufficiently with the booster battery attached, further diagnosis of the engine and starting system will be required. If necessary, refer to Section 28-01.

REMOVAL AND INSTALLATION

STARTER MOTOR

Removal



1. Disconnect the battery negative cable.
2. Raise the vehicle.
3. Disconnect the starter cable at the starter motor terminal.
4. Remove the bolt attaching the heat shield to the cylinder block.
5. Remove the starter attaching bolts, the heat shield rear support bracket, brace (transmission case to cylinder block), and the starter.

Installation

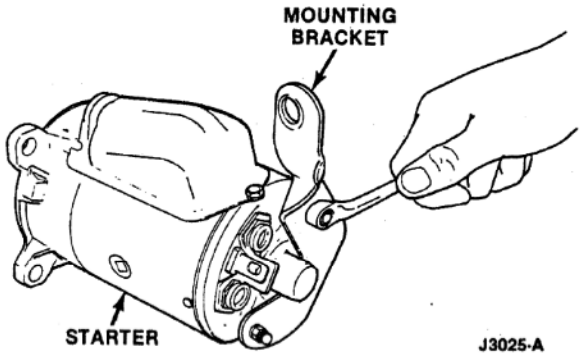
1. Position the starter, bracket, brace, and heat shield.

   Install the attaching bolts and tighten to 20 to 27 N·m (15 to 20 lb-ft) torque.
2. Install the heat shield attaching bolt.
3. Tighten the starter support bracket at the starter after tightening at the cylinder block.
4. Connect the starter cable.
5. Lower the vehicle.
6. Connect the battery negative cable.

STARTER DRIVE GEAR

Removal

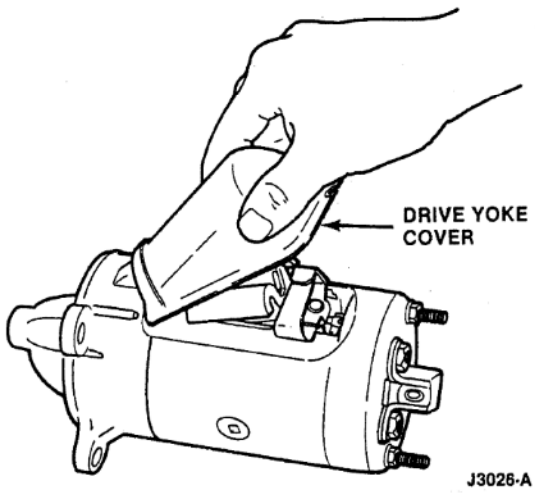
1. Remove the starter from the engine. If necessary, refer to the procedure in this section.
2. Remove the mounting bracket from the front of the starter.



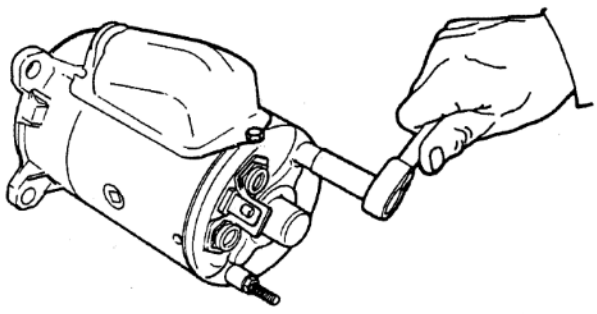
REMOVAL AND INSTALLATION

STARTER DRIVE GEAR
Removal (Continued)

3. Remove the drive yoke cover

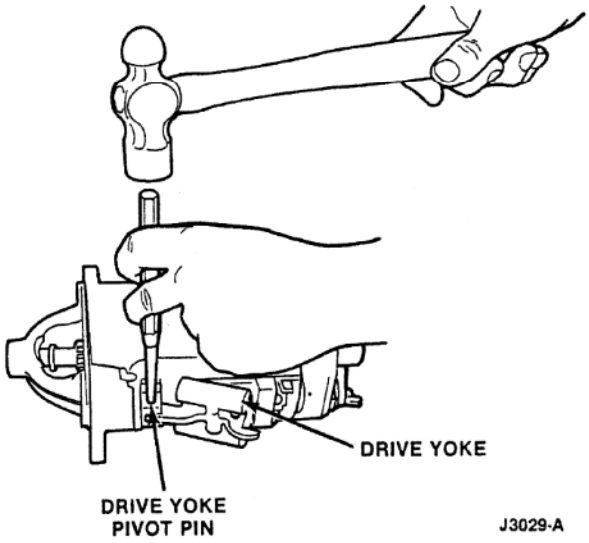


4. Remove the through-bolts.

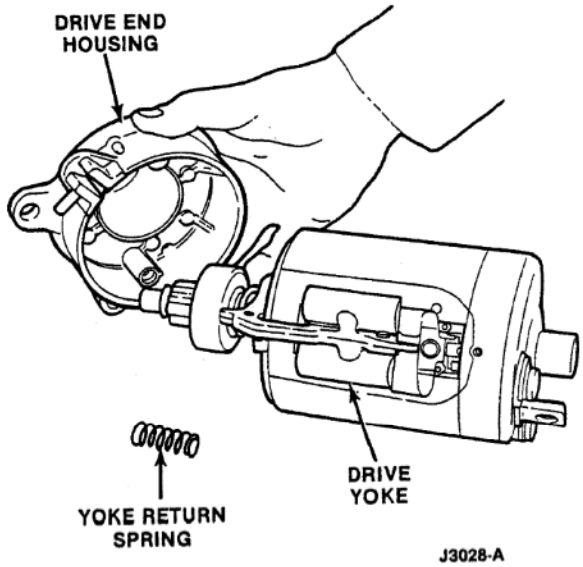


NOTE: After the through-bolts are removed, take care to hold the brush end plate and armature in position.

5. Remove the drive yoke pivot pin using a 5.5 mm (.218 in) diameter pin punch.



6. Remove the drive end housing, yoke return spring and drive yoke.

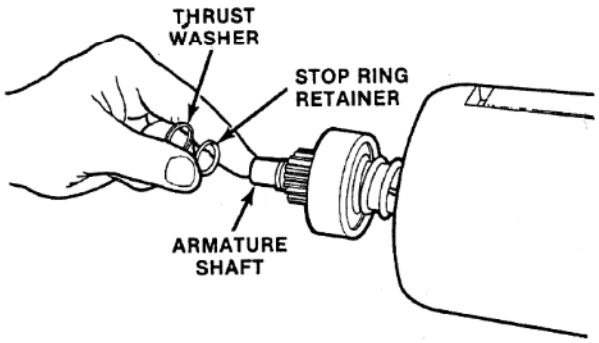


REMOVAL AND INSTALLATION

STARTER DRIVE GEAR

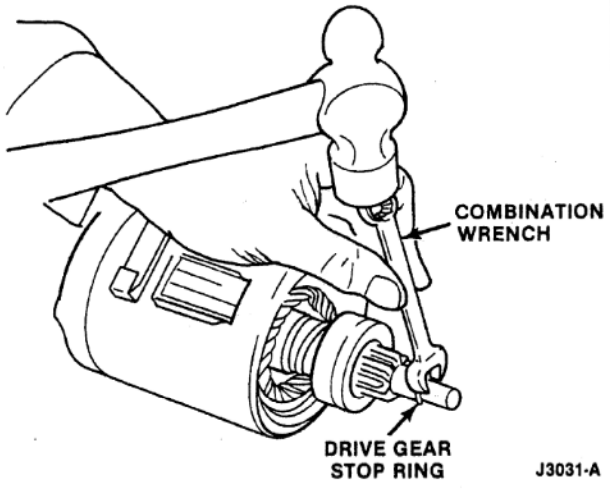
Removal (Continued)

7. Remove the thrust washer and stop ring retainer from the armature shaft.

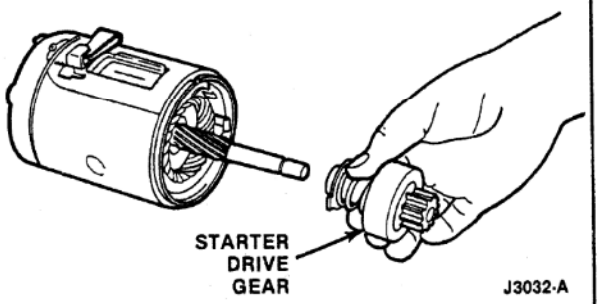


8. Remove the drive gear stop ring using a combination wrench and hammer.

   Discard the stop ring.

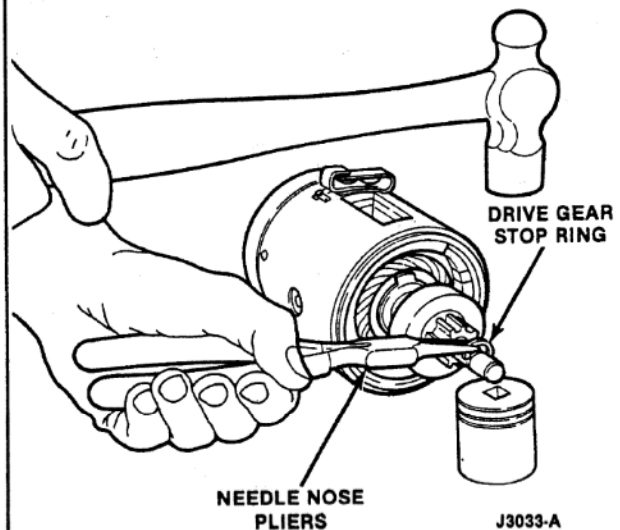


9. Remove the starter drive gear.



Installation

1. Lubricate the armature shaft splines with a thin coating of Lubriplate 777 or equivalent.
2. Install the starter drive gear.
3. Install a new stop ring using needle nose pliers and a hammer.

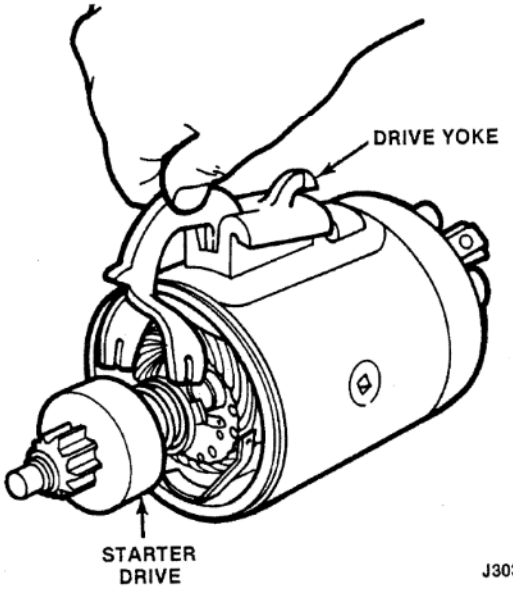


REMOVAL AND INSTALLATION

STARTER DRIVE GEAR

Installation (Continued)

4. Position the drive yoke. Make sure the drive yoke is properly engaged with the starter drive.

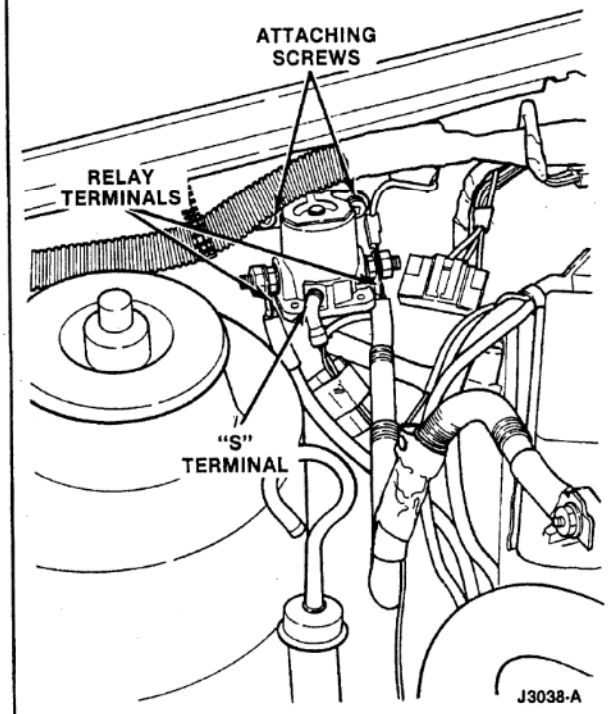


5. Install the stop ring retainer and thrust washer.
6. Lubricate the bushing in the end housing with lubricant C1AZ-19590-B, or equivalent.
7. Install the yoke return spring and end housing.
8. While holding in position install the through-bolts.

   Tighten the through-bolts to 6 to 8 N·m (55 to 75 lb-in.).
9. Install pivot pin using a 5.5 mm (.218 in.) diameter pin punch.
10. Install the drive yoke cover.
11. Install the mounting bracket on the front of the starter. Do not tighten the attaching nuts at this time. The attaching nuts will be tightened when the starter is installed in the vehicle.
12. Install the starter. If necessary, refer to the procedure in this section.

STARTER RELAY

Removal



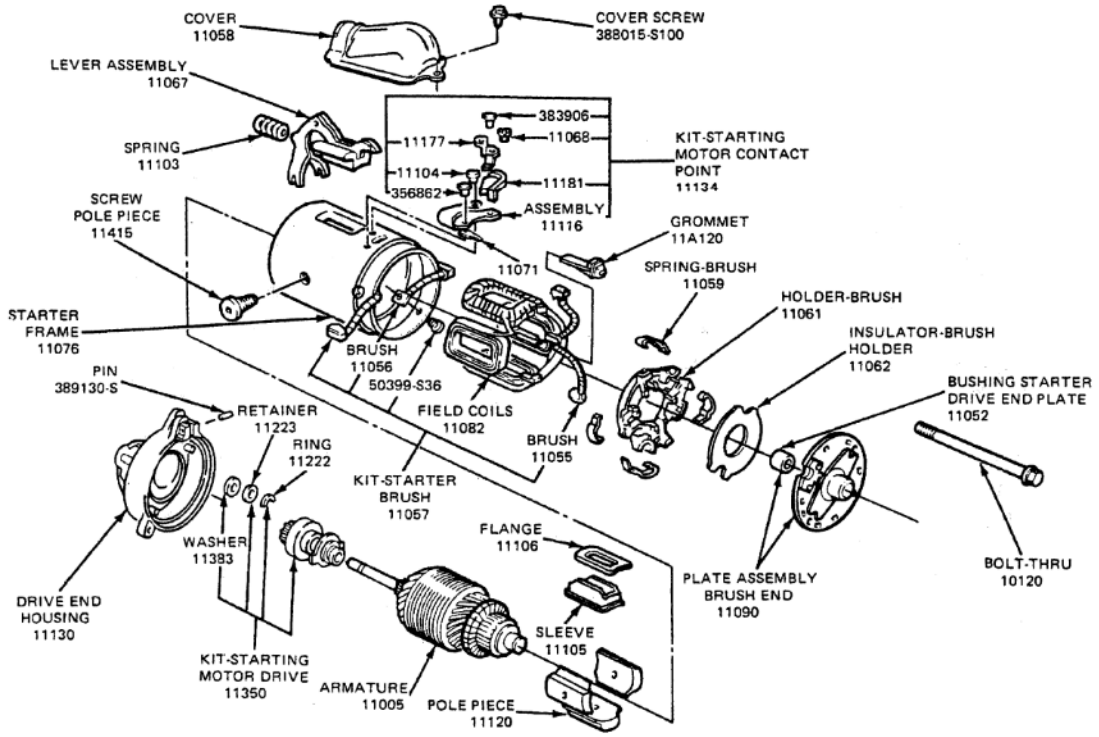
1. Disconnect the battery negative cable.
2. Disconnect the wire connector at the starter relay "S" terminal.
3. Remove the starter cable attaching nuts. Remove the cables from the relay terminals.
4. Remove the relay attaching screws and the relay.

Installation

1. Position the relay and install the attaching screws.
2. Position the starter cables on the relay terminals and install the attaching nuts.
3. Connect the wire to the "S" terminal.
4. Connect the battery negative cable.

DISASSEMBLY AND ASSEMBLY

STARTER MOTOR DISASSEMBLED VIEW

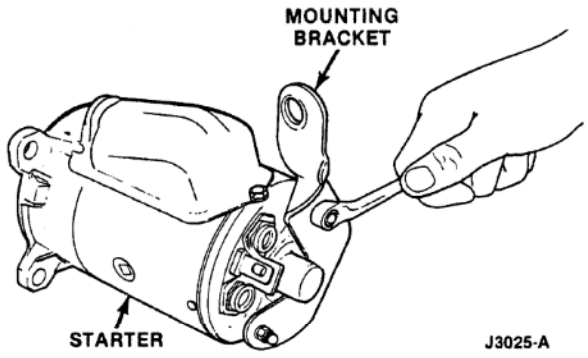


STARTER MOTOR
Disassembly

NOTE: The following disassembly procedure breaks the starter motor down into its major components and sub-assemblies. After disassembling the starter to this point, refer to the Component Test Chart where specific tests are performed to isolate a problem component.

In some cases, further disassembly of the starter may be necessary once the problem component is found. In such cases, refer to the necessary sub-assembly replacement procedure.

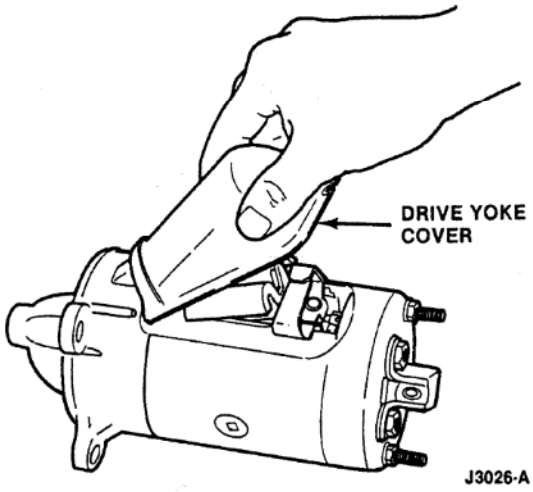
1. Remove the mounting bracket from the front of the starter.



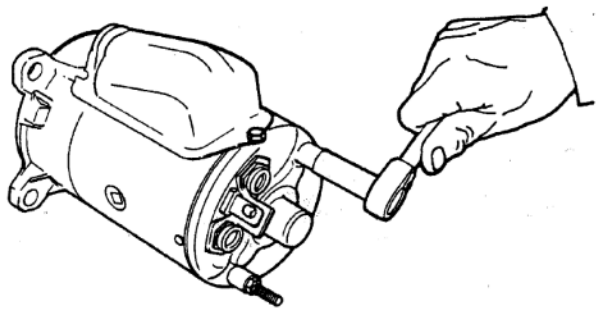
DISASSEMBLY AND ASSEMBLY

STARTER MOTOR DISASSEMBLY
Disassembly (Continued)

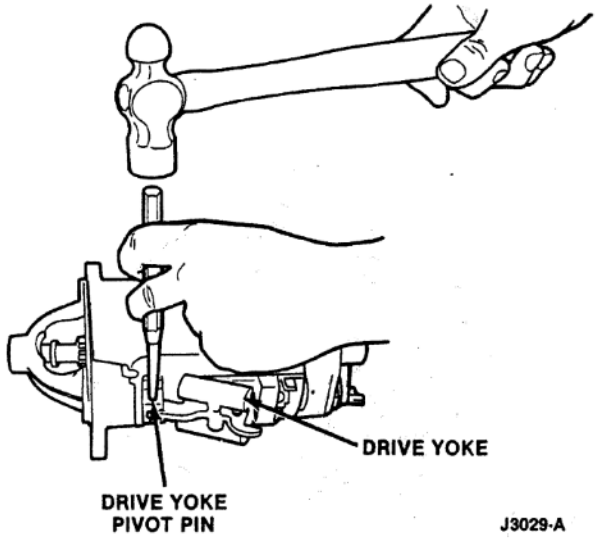
2. Remove the drive yoke cover.



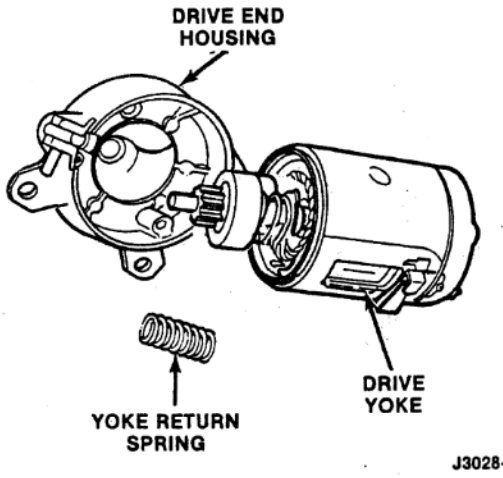
3. Remove the through-bolts.



4. Remove the drive yoke pivot pin using a 5.5 mm (.218 in.) diameter pin punch.



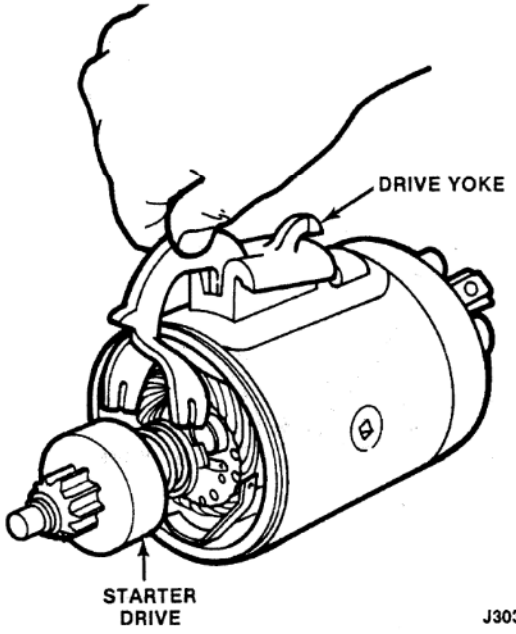
5. Remove the drive end housing and yoke return spring.



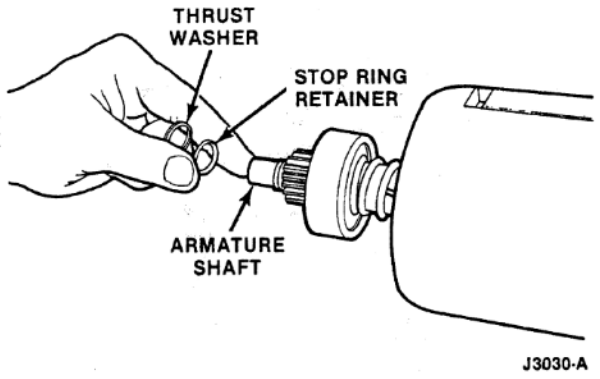
DISASSEMBLY AND ASSEMBLY

STARTER MOTOR DISASSEMBLY
Disassembly (Continued)

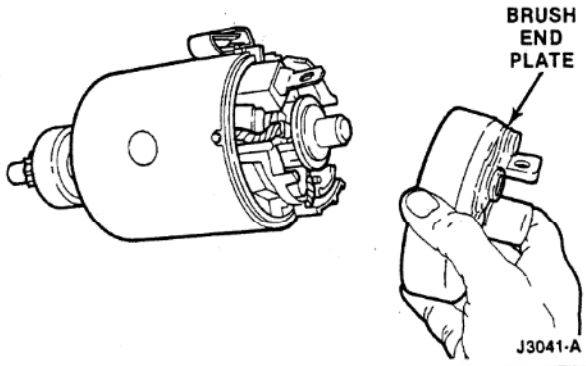
6. Remove the drive yoke.



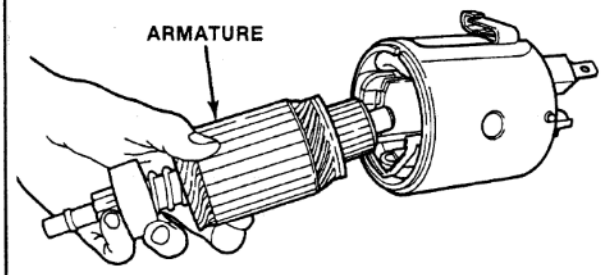
7. Remove the thrust washer and stop ring retainer from the armature shaft.



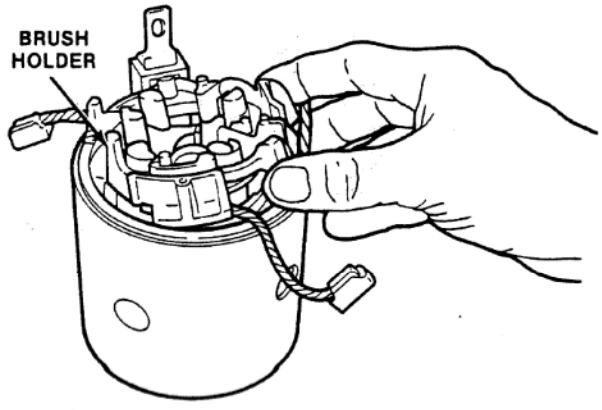
8. Remove the brush end plate.



9. Remove the armature.

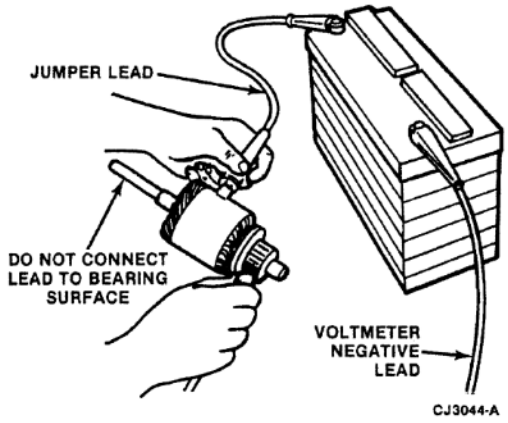
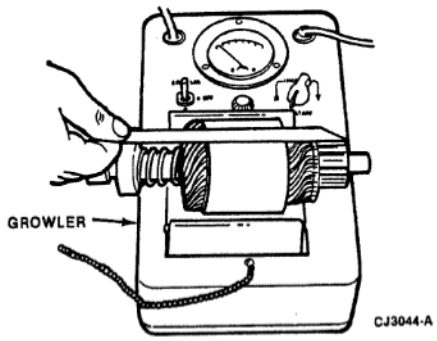


10. Remove the brush holder.



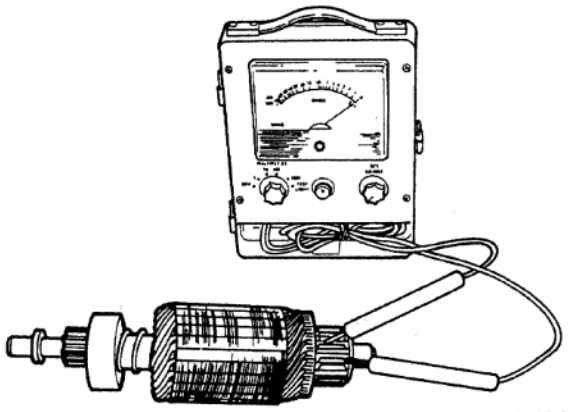
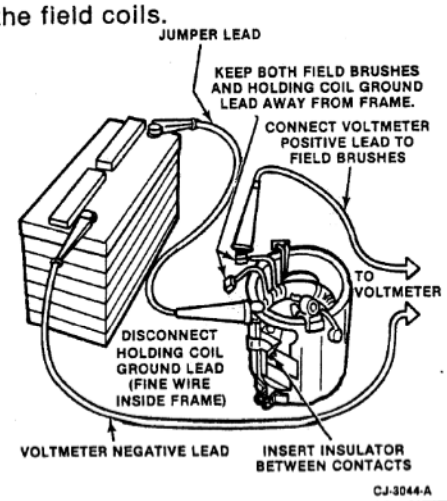
DISASSEMBLY AND ASSEMBLY

COMPONENT TEST AND INSPECTION CHART
STARTER MOTOR

TEST/INSPECTION	RESULTS/ACTION
ARMATURE GROUND Connect a voltmeter and battery as shown. While holding one test lead against the armature core, touch each commutator segment with the other test lead.  	If a voltage reading occurs, the armature windings are grounded and a new armature must be installed.
ARMATURE SHORTS Place the armature in a growler. Hold a thin steel strip (hacksaw blade) loosely on top of the armature and turn on the growler. Turn the armature until the entire armature core has passed under the strip.  	If a short circuit exists, the strip will vibrate when the shorted section passes under the strip. If the strip vibrates, replace the armature.

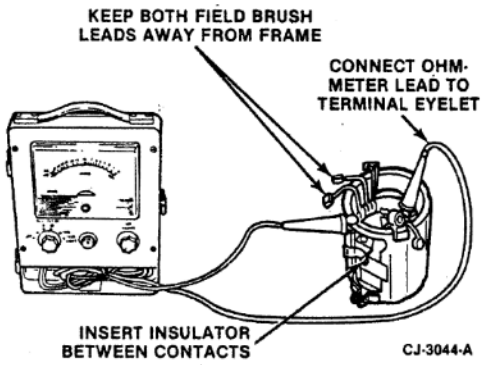
DISASSEMBLY AND ASSEMBLY

COMPONENT TEST AND INSPECTION CHART
STARTER MOTOR (Continued)

TEST/INSPECTION	RESULTS/ACTION
ARMATURE OPENS An open circuit armature may sometimes be detected by examining the commutator for evidence of burning. A burn spot on the commutator is caused by an arc formed every time the commutator segment connected to the open circuit winding passes under a brush. To test the armature coils for opens, touch one ohmmeter lead to a commutator segment. Touch the remaining ohmmeter lead to an adjacent commutator segment. Repeat the test on each adjacent set of commutator segments.	If burned spots are evident, replace the armature. If any adjacent set of commutator segments gives a high resistance reading, replace the armature.  CJ3044-A
FIELD COIL GROUND Inspect the field winding coils for signs of burning or overheating. Connect a voltmeter and battery as shown. Connect one test lead to the starter frame. Touch the remaining test lead to the field winding brushes.	Replace field coils if signs of overheating are evident. If a voltmeter reading occurs at either field brush, replace the field coils. 

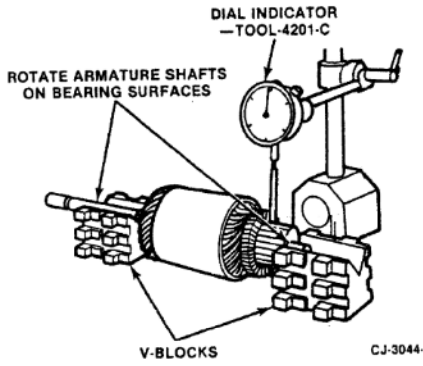
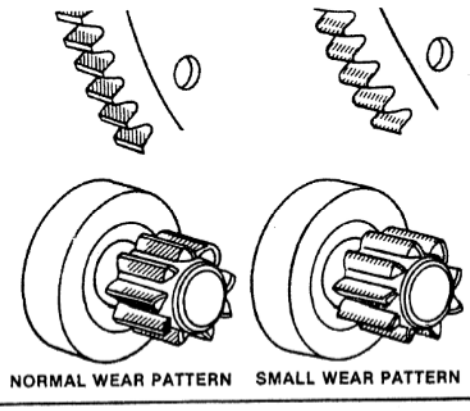
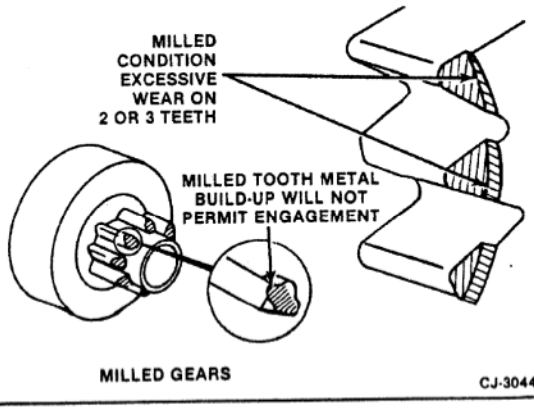
DISASSEMBLY AND ASSEMBLY

COMPONENT TEST AND INSPECTION CHART
STARTER MOTOR (Continued)

TEST/INSPECTION	RESULTS/ACTION
BRUSH HOLDER Inspect the brush holder for a cracked or broken condition.  	Ohmmeter reading should be 2.0 to 3.5 ohms. If the resistance reading is above or below this specification, replace the field coils.
HOLD-IN COIL RESISTANCE **NOTE:** Insert a piece of paper between the starter contact points. Make sure field coil brushes and holding coil ground are not touching the starter frame. Touch an ohmmeter lead to the starter battery terminal. Touch the remaining ohmmeter lead to the starter frame.	If the brush holder is cracked or broken, replace the brush holder.
BRUSHES Inspect the brushes for burning and excessive wear.	If the brushed are burned or excessively worn, they must be replaced.
BUSHINGS Inspect the drive end housing and end plate bushings for excessive wear or scoring.	If the bushings are worn or show signs of scoring, they must be replaced.

DISASSEMBLY AND ASSEMBLY

COMPONENT TEST AND INSPECTION CHART
STARTER MOTOR (Continued)

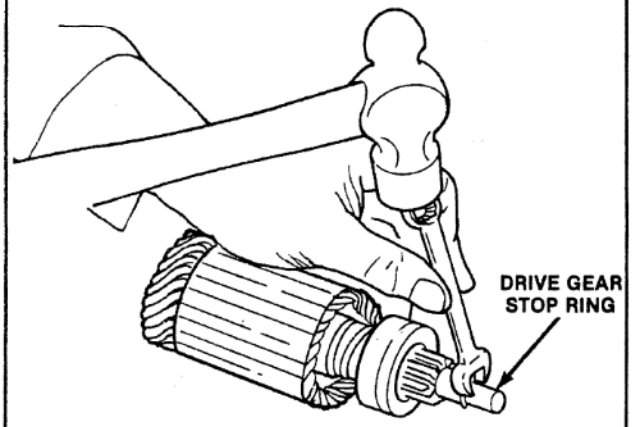
TEST/INSPECTION	RESULTS/ACTION
ARMATURE RUNOUT Inspect the armature core and field coil insulation for signs of scuffing. If it appears the armature has been rubbing against the field coils, check armature shaft runout using V-blocks and a dial indicator. The drive end housing and end plate bushing should also be checked for excessive wear.  	If armature shaft runout exceeds 0.130 mm (0.005 in.), replace the armature.
DRIVE AND RING GEARS Inspect the wear pattern on the drive and ring gears. Inspect the entire circumference of the ring gear for damage when the drive gear teeth are damaged. The ring gear wear pattern will be found in two places around the ring gear.  	If the drive gear or ring gear show signs of excessive wear or milling, they must be replaced. **NOTE:** If the ring is damaged, the flex plate (automatic transmission) or flywheel (manual transmission) must be replaced. Refer to the appropriate section. 

DISASSEMBLY AND ASSEMBLY

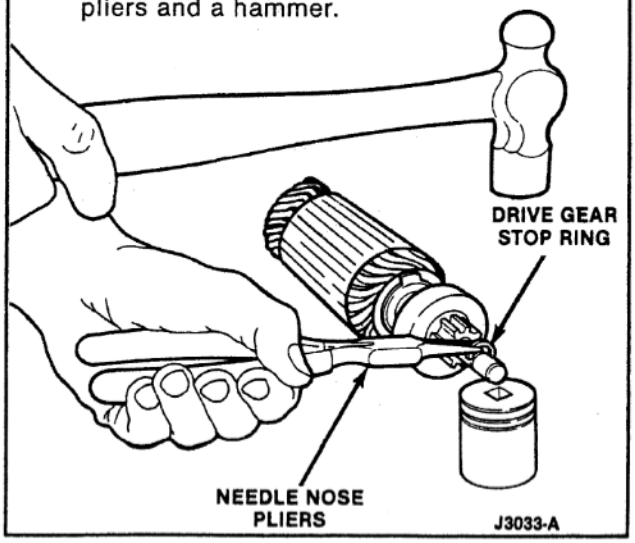
SUBASSEMBLY REPLACEMENT

Armature

1. Remove the drive gear stop ring using a combination wrench and hammer.
   Discard the stop ring.

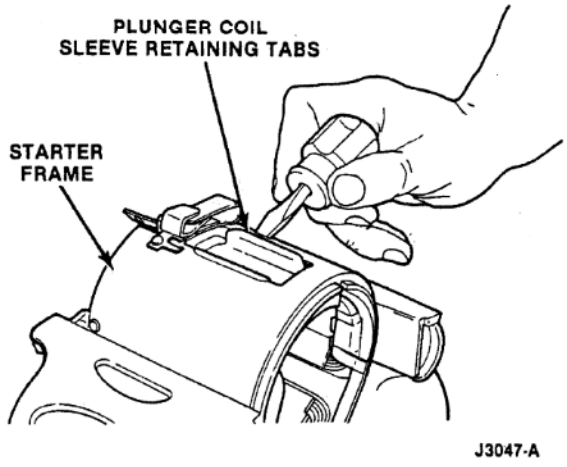


2. Remove the drive gear.
3. Lubricate the armature shaft splines with a thin coating of Lubriplate 777, or equivalent.
4. Install the drive gear.
5. Install a new stop ring using needle nose pliers and a hammer.

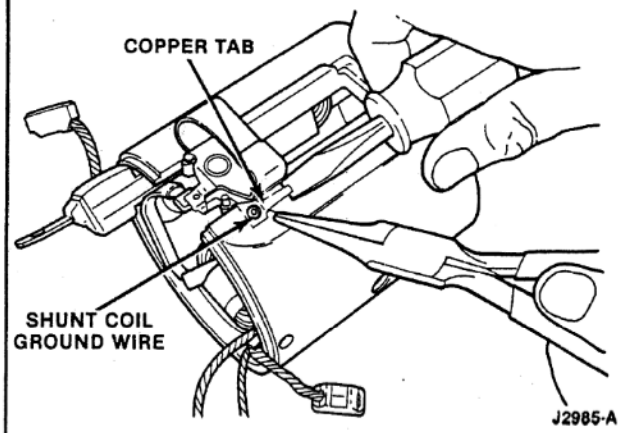


Field Coils

1. Bend back the retaining tabs and remove the plunger coil sleeve from the starter frame.



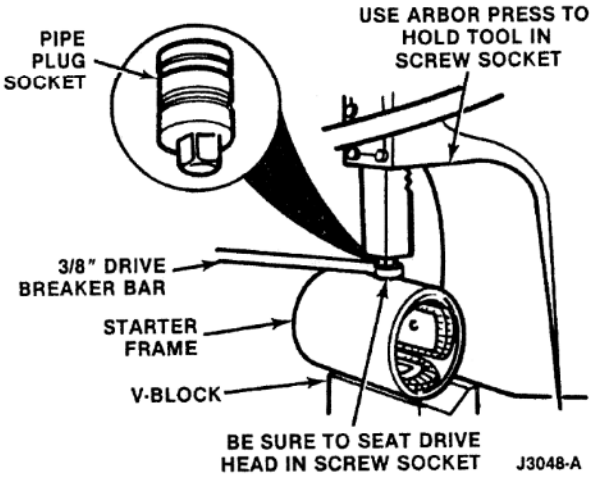
2. Lift the copper tab riveted to the starter frame and detach the shunt coil ground wire.



DISASSEMBLY AND ASSEMBLY

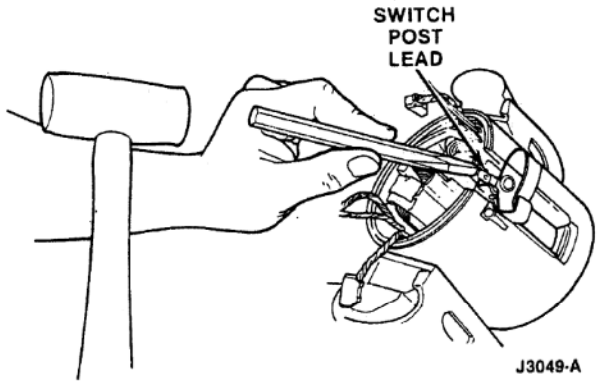
SUBASSEMBLY REPLACEMENT
Field Coils (Continued)

3. Remove the pole shoe attaching screws, using a 9/32 inch pipe plug socket such as Snap-on PPM409, or equivalent.



NOTE: The arbor press is necessary to prevent wrench from slipping out of the screw.

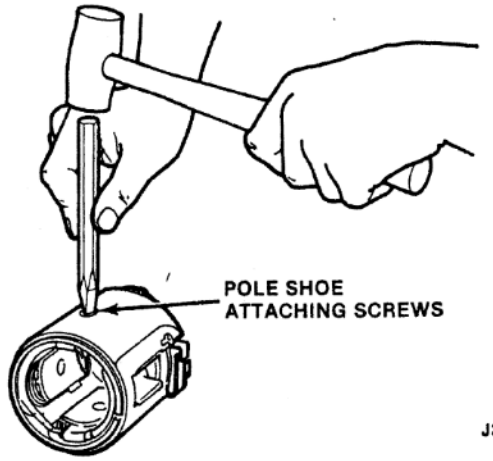
4. Cut the field coil connection at the switch post lead.



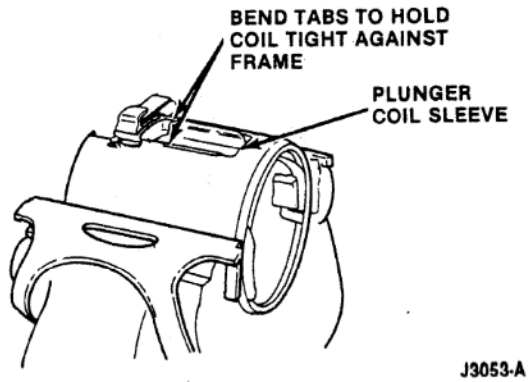
5. Remove the pole shoes and field coils.
6. Clean and tin field coil to switch post connections.
7. Install the pole shoes and field coils.
8. Install the pole shoe attaching screws.

NOTE: As the pole shoe attaching screws are tightened, strike the starter frame several sharp blows with a soft-faced hammer to seat and align the pole shoes.

9. Stake the pole shoe attaching screws using a sharp chisel.



10. Install the plunger coil sleeve and bend the tabs to hold the coil tight against the frame.

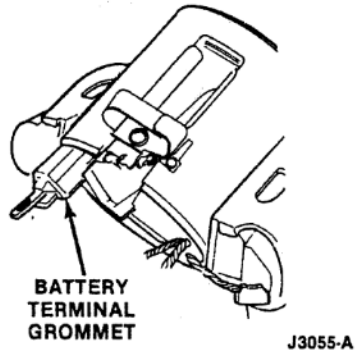


DISASSEMBLY AND ASSEMBLY

SUBASSEMBLY REPLACEMENT
Field Coils (Continued)

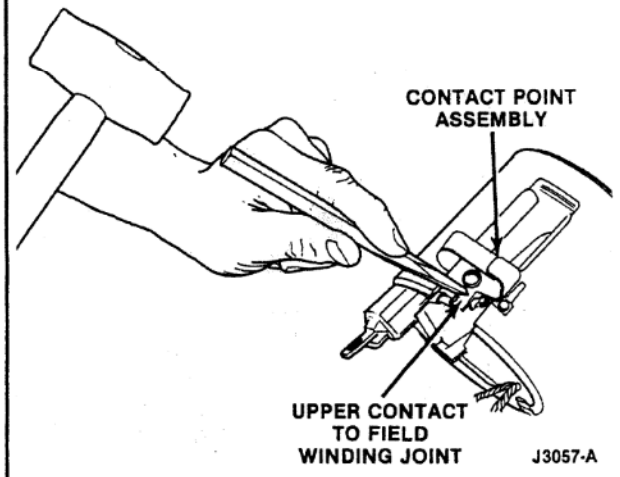
11. Lift the copper tab riveted to the starter frame and position the shunt coil ground wire under the tab.

12. Install the battery terminal grommet. Make sure it seats tight against the starter frame.

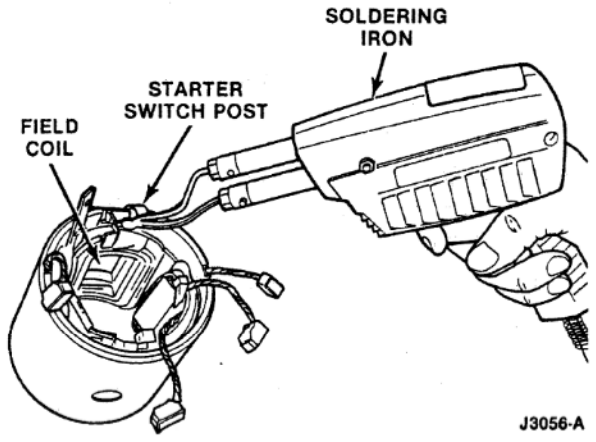


Contact Point Assembly

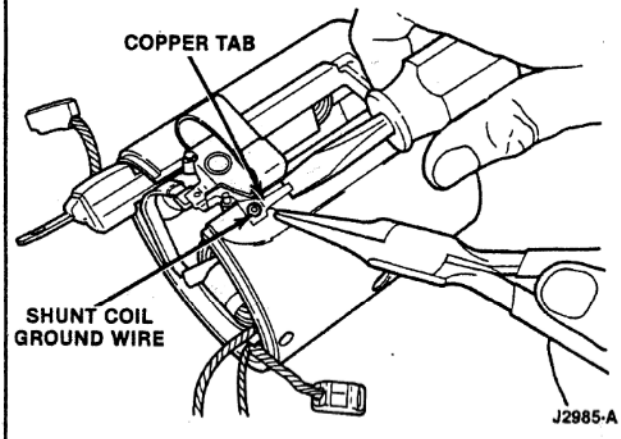
1. Cut the upper contact to field winding joint.



13. Solder field coil to starter switch post using a 300 watt soldering gun and rosin core solder.



2. Lift the copper tab riveted to the starter frame and detach the shunt coil ground wire.

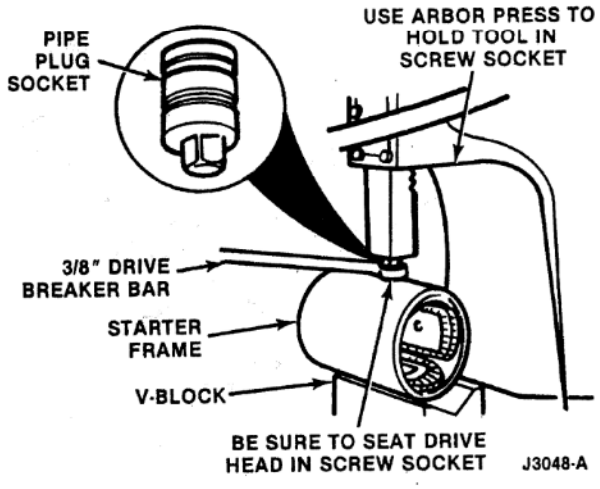


DISASSEMBLY AND ASSEMBLY

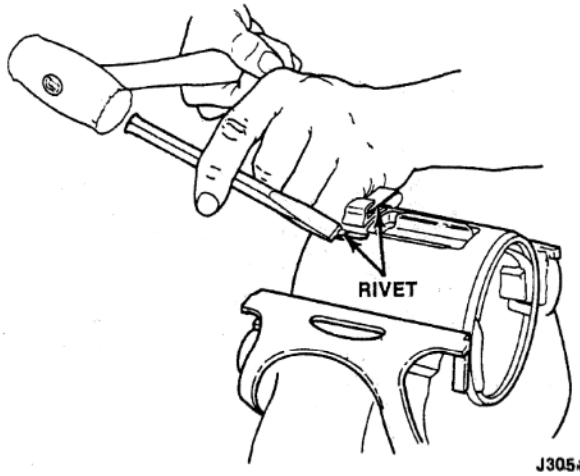
SUBASSEMBLY REPLACEMENT

Contact Point Assembly (Continued)

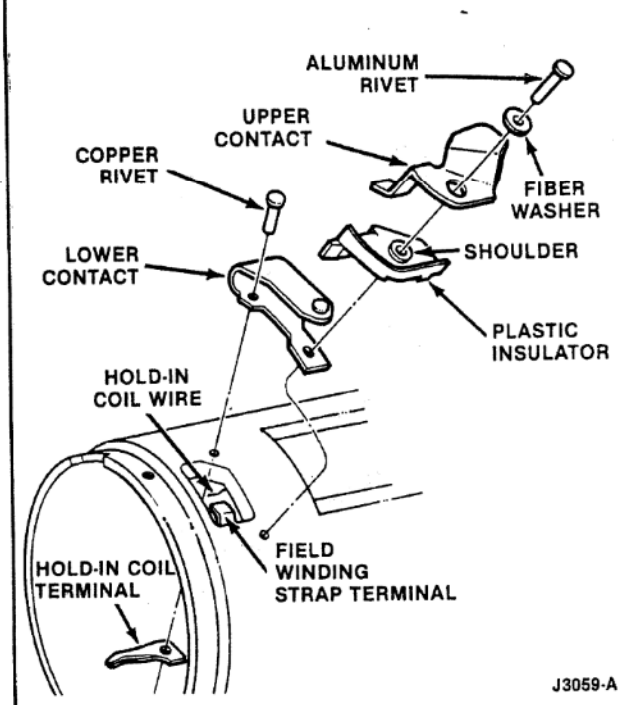
3. Remove the pole shoe attaching screws using a 9/32-inch pipe plug socket such as Snap-on PPM409, or equivalent, and remove poleshoes.



4. Cut the contact point attaching rivets from the frame using a sharp chisel and remove the contact point assembly.



5. Position the lower contact and the hold-in coil terminal on the starter frame.



6. Install the lower contact attaching rivet (copper).

NOTE: Make sure the holes for the second rivet are aligned before installing the copper rivet.

7. Position the insulator, upper contact and fiber washer on the starter frame and install the upper contact attaching rivet (aluminum).

NOTE: Make sure the upper contact is positioned on the insulator shoulder before installing the aluminum rivet.

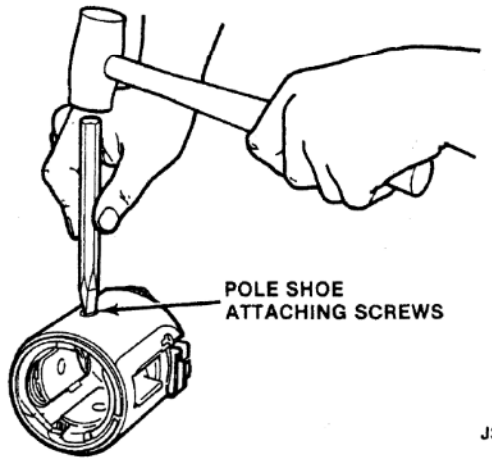
8. Install the pole shoe attaching screws.

NOTE: As the pole shoe attaching screws are tightened, strike the starter frame several sharp blows with a soft-faced hammer to seat and align the pole shoes.

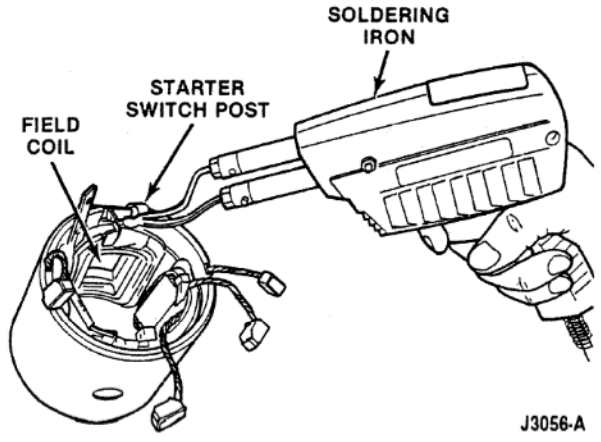
DISASSEMBLY AND ASSEMBLY

SUBASSEMBLY REPLACEMENT
Contact Point Assembly (Continued)

9. Stake the pole shoe attaching screws using a sharp chisel.

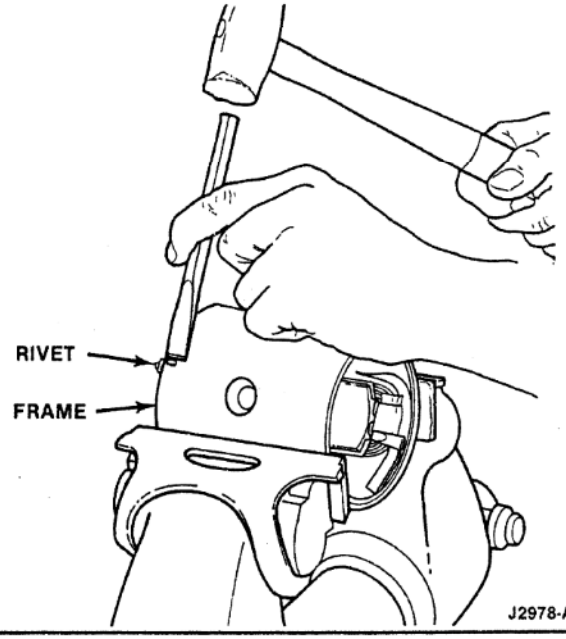


10. Solder the upper contact-to-field winding joint using a 300 watt soldering gun and rosin core solder.

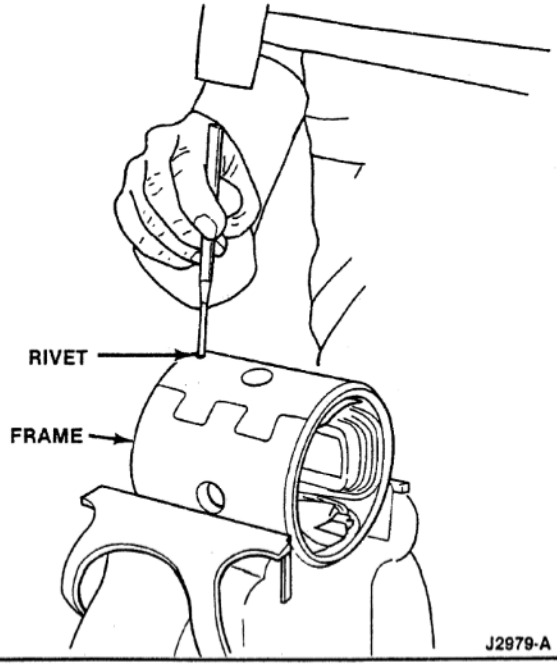


Brushes

1. Cut the attaching rivets from the frame using a sharp chisel.



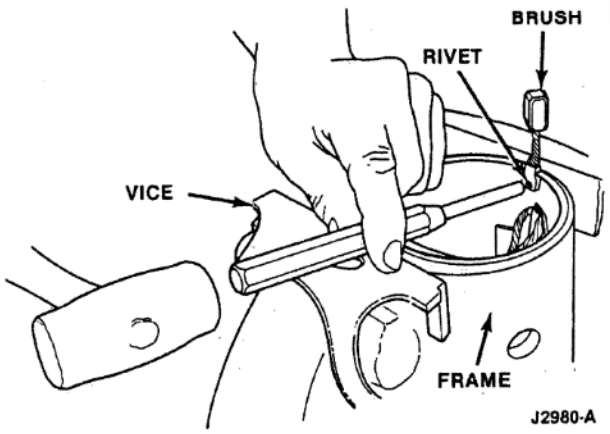
2. Drive the rivets out of the frame using a suitable punch and remove the ground brushes.



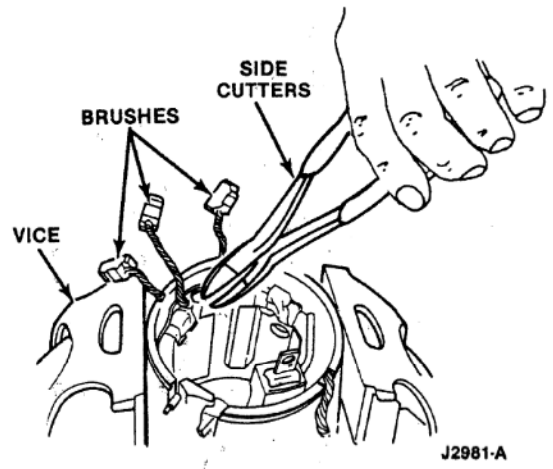
DISASSEMBLY AND ASSEMBLY

SUBASSEMBLY REPLACEMENT
Brushes (Continued)

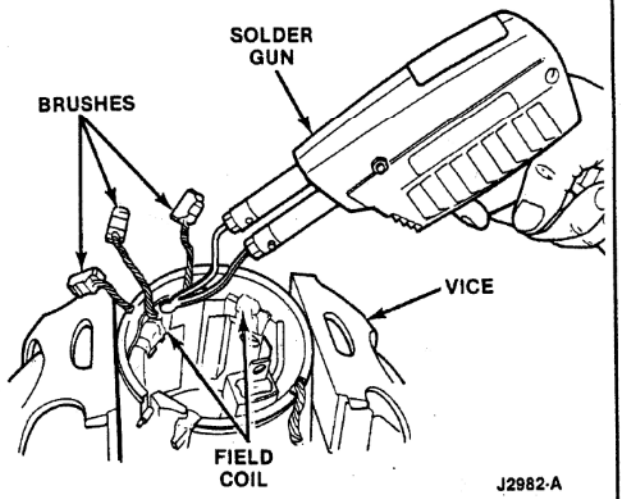
3. Install the ground brushes and rivets. Clamp the frame in a vise and peen over the rivets.



4. Cut the insulated brush leads at the field coils with side cut pliers.

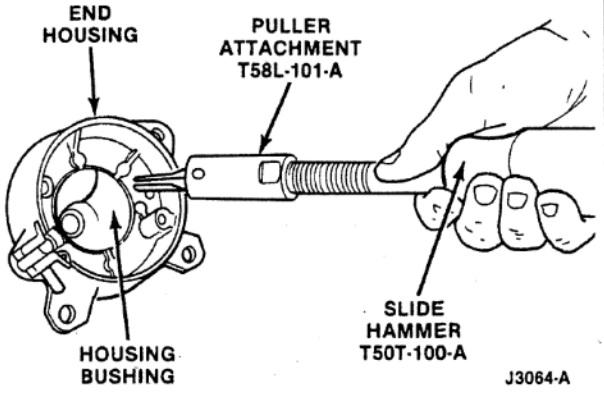


5. Clean and tin the field coil connections. Attach the insulated brushes to the field coils and solder using a 300 watt soldering gun and rosin core solder.



Drive End Housing Bushing

1. Remove the end housing bushing using Puller Attachment T58L-101-A and Slide Hammer T50T-100-A, or equivalent.



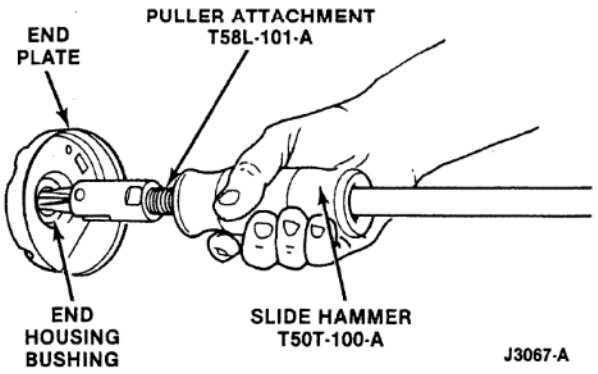
2. Install the drive end housing bushing using a suitable driver.

DISASSEMBLY AND ASSEMBLY

SUBASSEMBLY REPLACEMENT

End Plate Bushing

1. Remove the end plate bushing, using Puller Attachment T58L-101-A and Slide Hammer T50T-100-A, or equivalent.

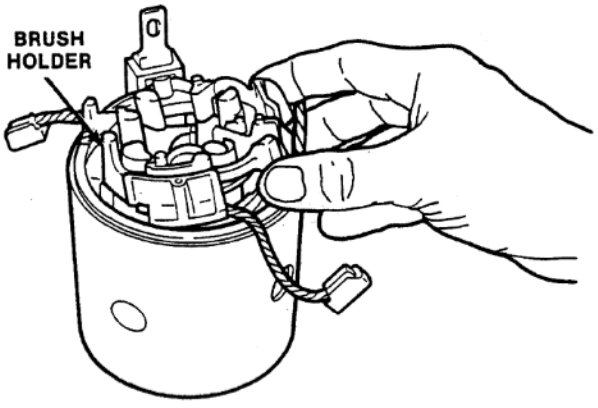


2. Install the end plate bushing using a suitable driver.

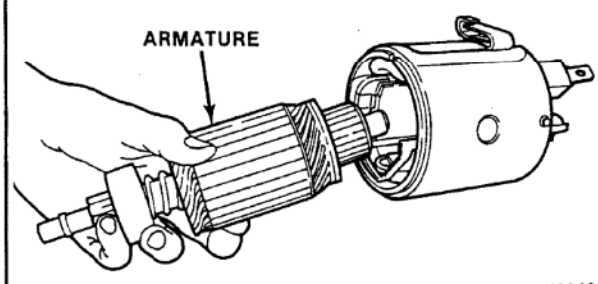
STARTER MOTOR

Assembly

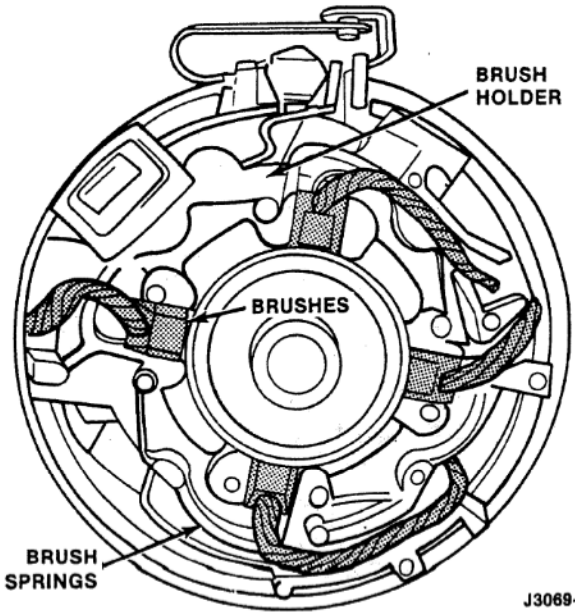
1. Install the brush holder.



2. Install the armature.



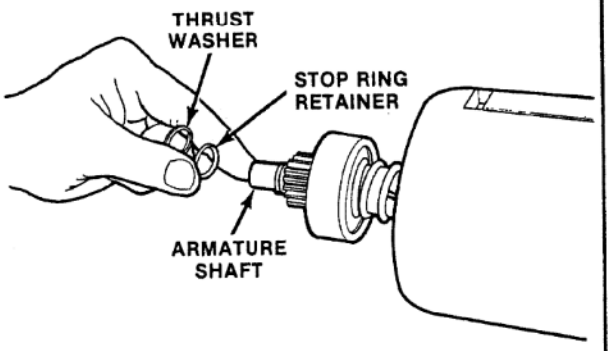
3. Pull back on the brush springs and insert the brushes in the holder. Make sure the brush leads are properly routed.



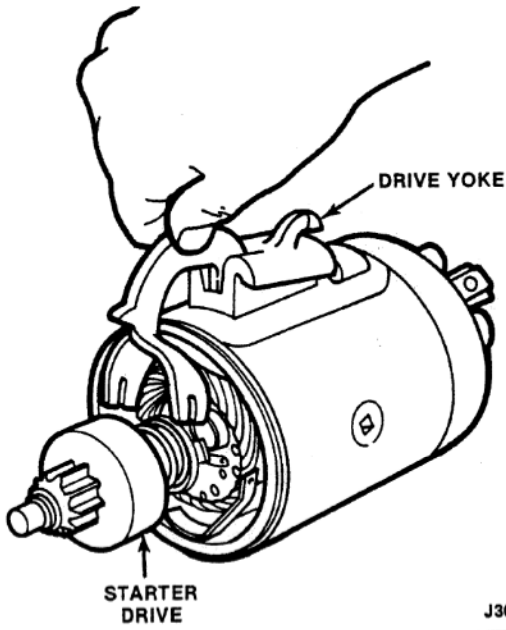
DISASSEMBLY AND ASSEMBLY

STARTER MOTOR
Assembly (Continued)

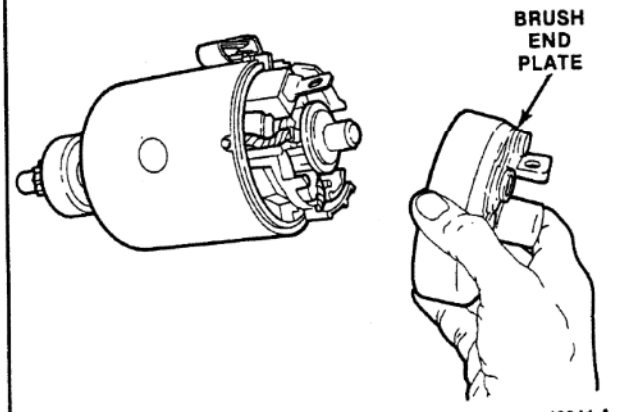
4. Install the stop ring retainer and thrust washer.



5. Position the drive yoke. Make sure the drive yoke fork engages the lugs on the drive gear.

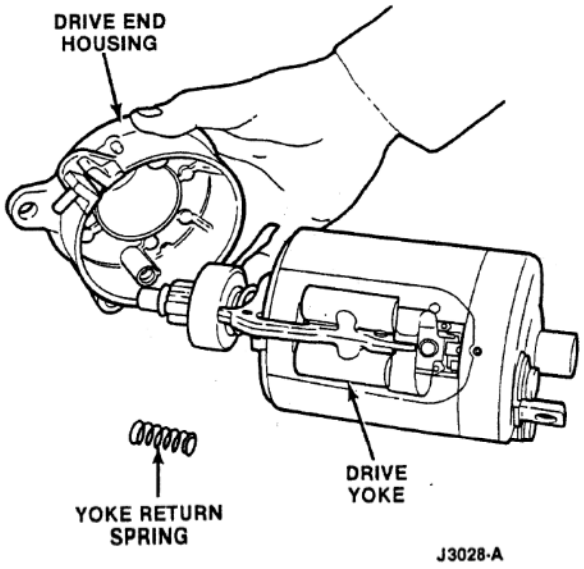


6. Install the brush end plate.



7. Install the yoke return spring and drive end housing.

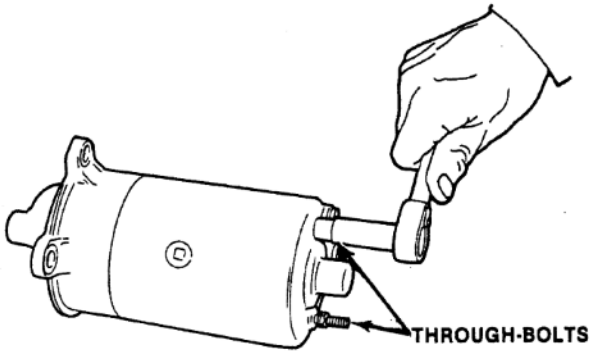
   Hold the housing in position against the yoke spring pressure.



DISASSEMBLY AND ASSEMBLY

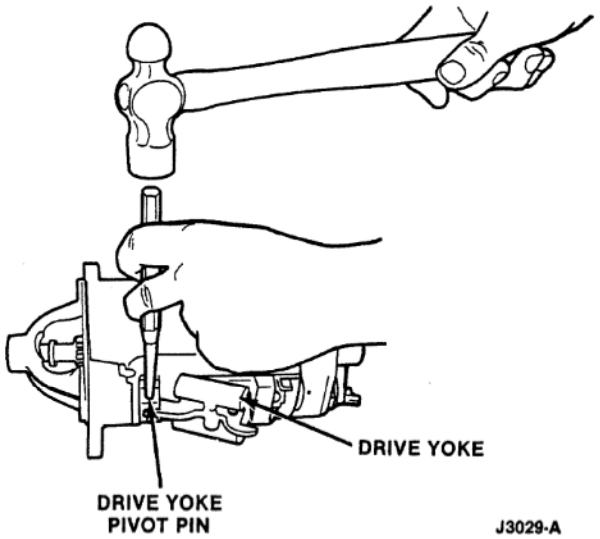
STARTER MOTOR ASSEMBLY
Assembly (Continued)

8. Install the through-bolts. Tighten the bolts to 6 to 8 N·m (55 to 75 lb-in).



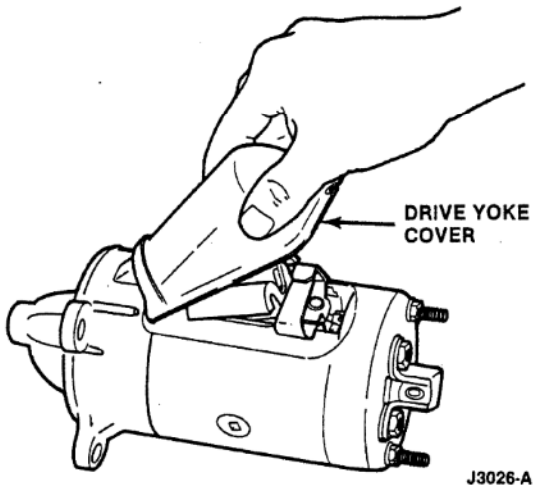
J3027-A

9. Install the drive yoke pivot pin using suitable punch.



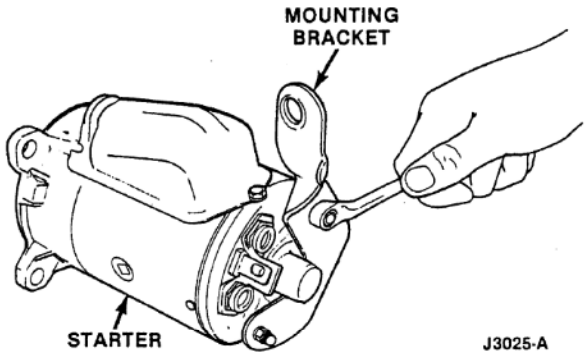
J3029-A

10. Install the drive yoke cover.



J3026-A

11. Install the mounting bracket on the front of the starter. Do not tighten the attaching nuts at this time.



J3025-A

GROUP 28 SPECIFICATIONS

STARTER TYPE:	Positive Engagement
CURRENT DRAW UNDER NORMAL LOAD:	150–250 amps
CURRENT DRAW UNDER NO LOAD:	80 amps
DIAMETER:	102 mm (4 in.)
NORMAL ENGINE CRANKING SPEED:	180–250 rpm
BRUSH LENGTH (NEW):	11.4 mm (.45 in.)
BRUSH WEAR LIMIT:	6.44 mm (.25 in.)
BRUSH SPRING TENSION:	22 N (80 oz.)
STARTER RELAY PULL IN WINDING RESISTANCE:	3–5 ohms
MAXIMUM VOLTAGE DROP (TOTAL):	0.5 volt
MAXIMUM COMMUTATOR RUNOUT:	0.130 mm (0.005 in.)

TORQUE CHART

ITEM	N·m	Lb-Ft
Mounting bolts	20–27	15–20
Through-bolts	6–8	55–75 (lb-in)
Mounting bracket attaching nuts	6–8	55–75 (lb-in)
Cable attaching screw	8–12	70–110 (lb-in)

CHARGING SYSTEM & BATTERY

GROUP 31 (10000)

TITLE SECTION	PAGE NO.	TITLE SECTION	PAGE NO.

BATTERY AND CHARGING SYSTEM DIAGNOSIS 31-01

GENERAL INFORMATION 1
INSPECTION 1
BATTERY TESTING 3
CHARGING SYSTEM CHECKING
- Warning Light Function Check 5
- Key-OFF Check 6
- Output Voltage Check 7
- Diode Check 7
- Regulator Bypass Check 8
- External Circuit Check 8
- Excitation Voltage Check 9
- Brush Check 10
- Field Check 10
- Output Current Check 11

BATTERIES 31-02

DESCRIPTION 1
REMOVAL AND INSTALLATION
- Battery 2
- Battery Replacement 3

GENERAL SERVICE PROCEDURES
- Battery Charging 4
- Cleaning 5

ALTERNATOR 31-12

DESCRIPTION 1
ADJUSTMENTS
- Drive Belt Tension 2

REMOVAL AND INSTALLATION
- Drive Belts 3
- Alternator 3
- Voltage Regulator 4

DISASSEMBLY AND ASSEMBLY
- Alternator 5

COMPONENT INSPECTION CHART 10
COMPONENT TEST CHART 11

GROUP 31

SPECIFICATIONS 1

SECTION 31-01 BATTERY AND CHARGING SYSTEM DIAGNOSIS

CONTENTS

Page

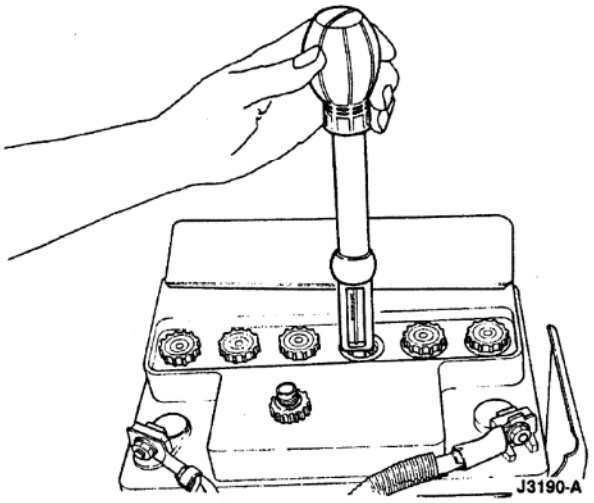
GENERAL INFORMATION 1

INSPECTION 1

BATTERY TESTING 3

CHARGING SYSTEM CHECKING

- Warning Light Function Check 5
- Key-OFF Check 6
- Output Voltage Check 7
- Diode Check 7
- Regulator Bypass Check 8
- External Circuit Check 8
- Excitation Voltage Check 9
- Brush Check 10
- Field Check 10
- Output Current Check 11



GENERAL INFORMATION

Battery and charging system complaints usually fall into one of three categories:

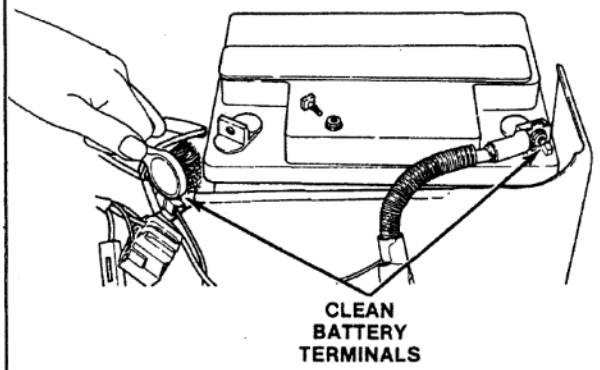
- Warning light doesn't go out when the engine is running
- Hard starting, dim lights, battery chronically low and occasionally dead
- High water consumption, short battery life, fuse and bulb burnouts

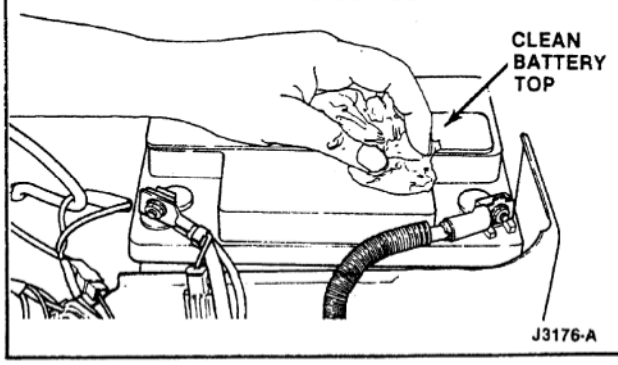
INSPECTION

Battery and charging system trouble is frequently due to physical, as opposed to electrical, factors: Loose or corroded connections, damaged wiring, slipping drive belts, dirty battery surfaces and terminals, or poor maintenance.

The first step, therefore, is a thorough inspection of the system.

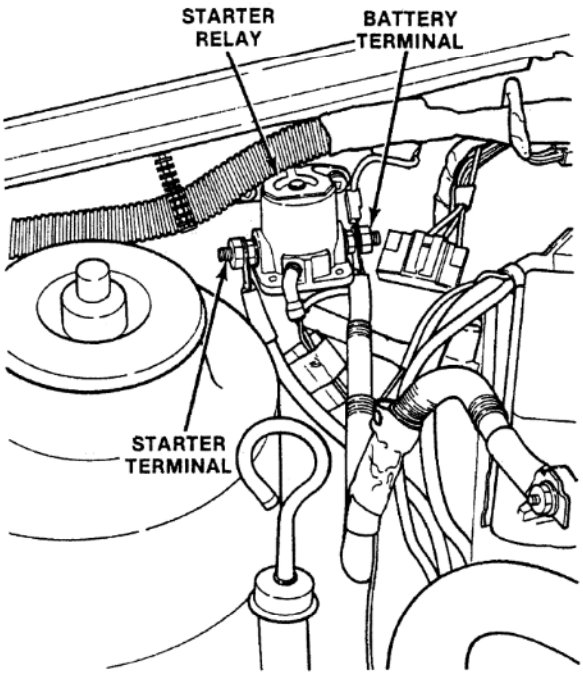
1. Be sure the battery terminals and the cable connections are clean and tight.

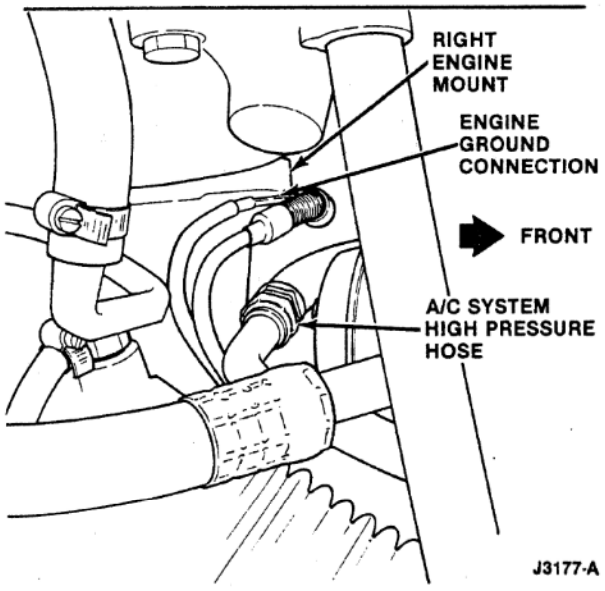




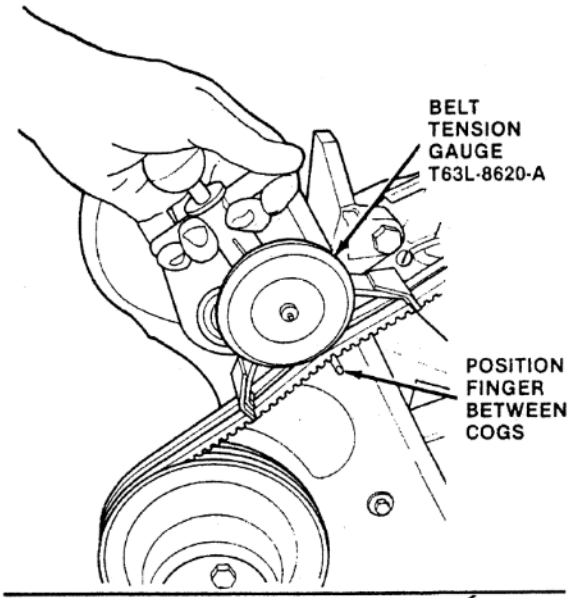
INSPECTION

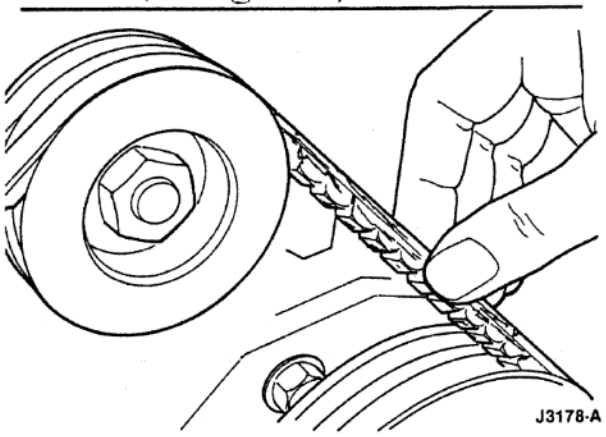
2. Check the battery cable connections to the starter relay and engine ground. There must be no rust, paint, or dirt at the connecting points.





3. Check the alternator drive belts for glazing or cracking, which may have been aggravated by previous slipping. If the sides of the belts are shiny or feel slick, replace them. Check belt tension, or tension new belts, using Belt Tension Gauge T63L-8620-A. If necessary, refer to Section 27-02 for the belt adjustment procedure. When using the tension gauge, be sure the gauge finger is positioned between the cog teeth on the inner surface of the belts.





4. Be sure the top surface of the battery is clean, free of moisture or foreign matter which could form a path for electrical leakage between terminals. Remove the caps and verify that the electrolyte level is about 1/4 inch above the top of the plates in each cell.

BATTERY TESTING

BATTERY TEST CHART

TEST STEP	RESULT ▶	ACTION TO TAKE
A0 VISUAL INSPECTION • Remove negative cable, then positive cable. • Check for dirty or corroded connections. If necessary, refer to the inspection procedures in this section.	~~OK~~ ▶ OK ▶	CLEAN terminals and clamps. GO to **A1**. GO to **A1**.
A1 LOOSE BATTERY POST • Check for loose battery post.	~~OK~~ ▶ OK ▶	REPLACE battery. GO to **A2**.
A2 CRACKED BATTERY COVER • Check for broken/cracked case or cover.	~~OK~~ ▶ OK ▶	REPLACE battery. GO to **A3**.
A3 BATTERY CAPACITY TEST • Use a high rate discharge tester with a variable rate control or a fixed rate tester with meter compensation for different battery electrical sizes. Follow instructions supplied with tester for the battery capacity test. If necessary, refer to the battery capacity test in this section.	~~OK~~ ▶ OK ▶	CHARGE battery for 20 minutes at 35 amps. REPEAT **A3**. (If battery fails second check, replace battery.) GO to **A4**.

RECOMMENDED DISCHARGE RATES

Battery Rating (Cold Cranking Amps.)	Discharge Rate (Amperes)
500	250

Voltage Readings at 15 seconds for good battery.

Approximate Battery Temp.	Minimum Voltage	Approximate Battery Temp.	Minimum Voltage
21°C (70°F)	9.6	−7°C (19°F)	8.9
15°C (59°F)	9.5	−10°C (14°F)	9.1
10°C (50°F)	9.4	−12°C (10°F)	8.7
3°C (37°F)	9.3	−18°C (0°F)	8.5

A4 VOLTAGE CHECK Measure open circuit voltage of battery with a digital voltmeter capable of reading 1/100 volt.	Over 12.4 volts ▶ 12.4 volts or less ▶	Battery OK. CHARGE battery.

CJ2829-B

CAUTION: Hydrogen and oxygen gases are produced during normal battery operation. This gas mixture can explode if flames, sparks or lighted tobacco are brought near the battery. When charging or using a battery in an enclosed space, always provide ventilation and shield your eyes.

WARNING: KEEP OUT OF REACH OF CHILDREN. BATTERIES CONTAIN SULFURIC ACID. AVOID CONTACT WITH SKIN, EYES, OR CLOTHING. ALSO, SHIELD YOUR EYES WHEN WORKING NEAR THE BATTERY TO PROTECT AGAINST POSSIBLE SPLASHING OF THE ACID SOLUTION. IN CASE OF ACID CONTACT WITH SKIN, EYES, OR CLOTHING, FLUSH IMMEDIATELY WITH WATER FOR A MINIMUM OF FIFTEEN MINUTES. IF ACID IS SWALLOWED, DRINK LARGE QUANTITIES OF MILK OR WATER, FOLLOWED BY MILK OF MAGNESIA, A BEATEN EGG, OR VEGETABLE OIL. CALL A PHYSICIAN IMMEDIATELY.

BATTERY TESTING

SPECIFIC GRAVITY CHECK

NOTE: If electrolyte level is low in any cell, add distilled water and charge the battery for 20 to 30 minutes before checking the specific gravity.

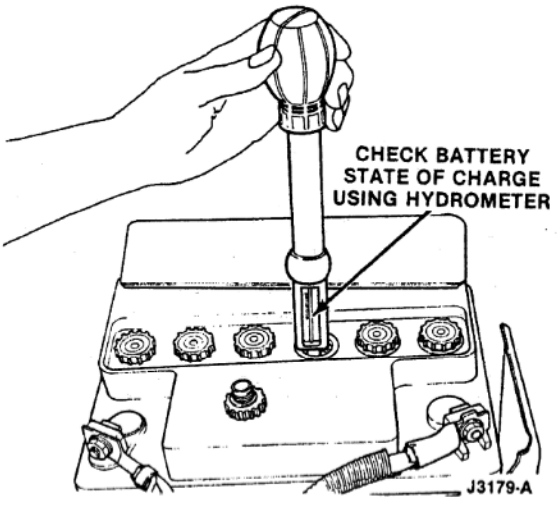
Use a hydrometer to check the specific gravities of all the cells.

In order to obtain an accurate specific gravity reading it must be corrected to the standard temperature of 26 °C (80 °F). The correction factor of four points (0.004) is used for each – 12 °C (10 °F) change in temperature. Four points (0.004) are added to the indicated reading for each – 12 °C (10 °F) increment above 26 °C (80 °F) and four points (0.004) are subtracted for each – 12 °C (10 °F) increment below 26 °C (80 °F).

If the difference between cells is 50 points (0.050) or more, the battery is not satisfactory for service and should be replaced.

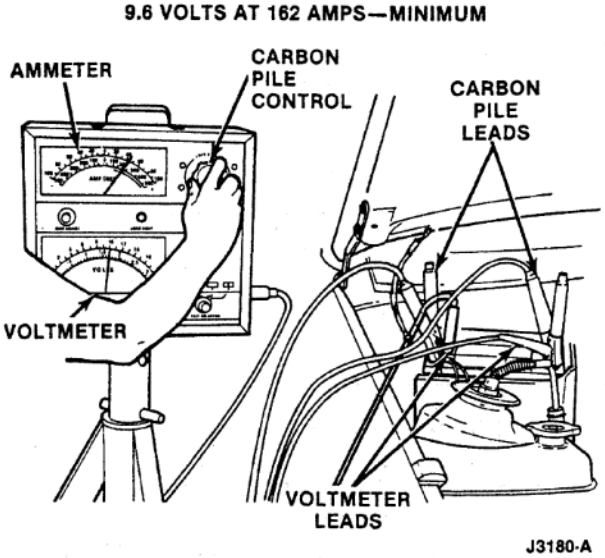
If the difference between cells is less than 50 points (0.050) and one or more cells are less than 1.225, charge the battery for 20 minutes at 35 amps and conduct the capacity test. If the battery fails, replace the battery. If it passes, add water, if necessary, and charge the battery.

If the difference between cells is less than 50 points (0.050) and all cells are above 1.225, conduct the capacity test. If the battery fails, replace the battery. If it passes, return to service.



CAPACITY TEST

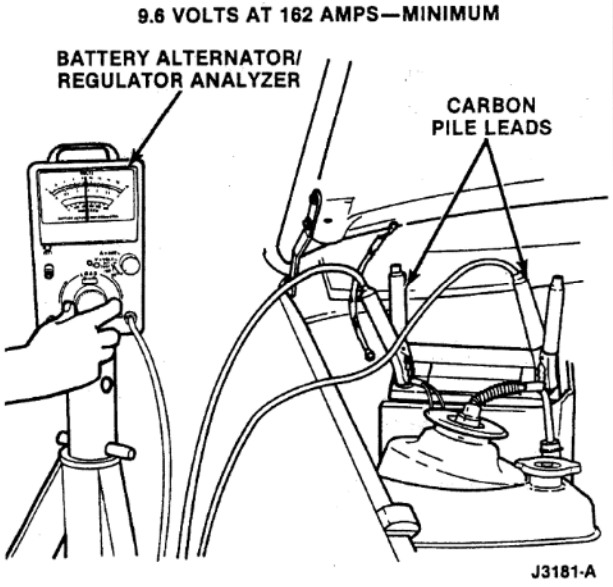
5. If in doubt about battery condition, due to age or evidence of indifferent maintenance, a battery capacity test will determine whether the battery is serviceable or should be replaced. Connect a 300- to 500-amp ammeter in series with a carbon pile load resistor across the battery terminals. **First be sure the carbon pile is turned to the OFF or NO LOAD position.** Connect a voltmeter across the terminals to indicate battery voltage. Then, with the carbon pile adjust the load in amperes to a value three times the ampere-hour rating of the battery (3 × 54 A/H, or 162 amperes for the original-equipment XR4Ti battery). Do not keep the load on the battery for longer than 15 seconds while observing the voltage. If it drops below 9 volts, replace the battery.



BATTERY TESTING

CAPACITY TEST (Continued)

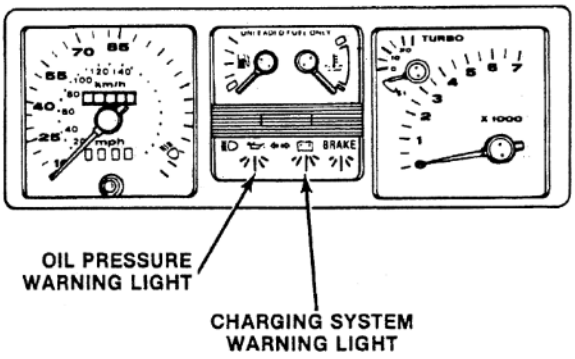
If specialized test equipment is available, such as the Rotunda Battery-Alternator-Regulator Analyzer, follow the manufacturer's instructions for the battery capacity test.



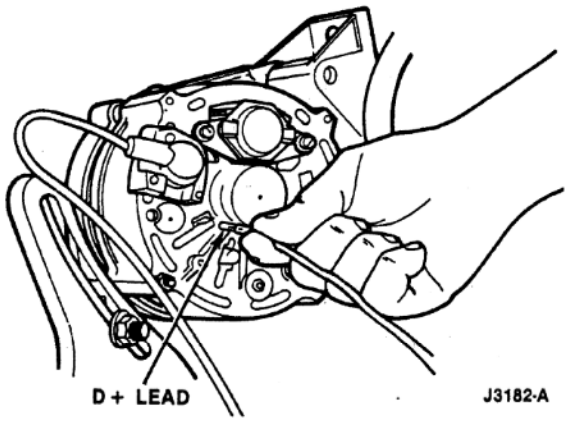
CHARGING SYSTEM CHECKING

WARNING LIGHT FUNCTION CHECK

1. Incorrect warning light function can result from a ground in the alternator excitation lead, from the warning light to the alternator D+ terminal. Check the warning lights by turning the key ON, without starting the engine. Charging system and oil pressure lights should glow, and the brake lights, too, if the parking brake is set.



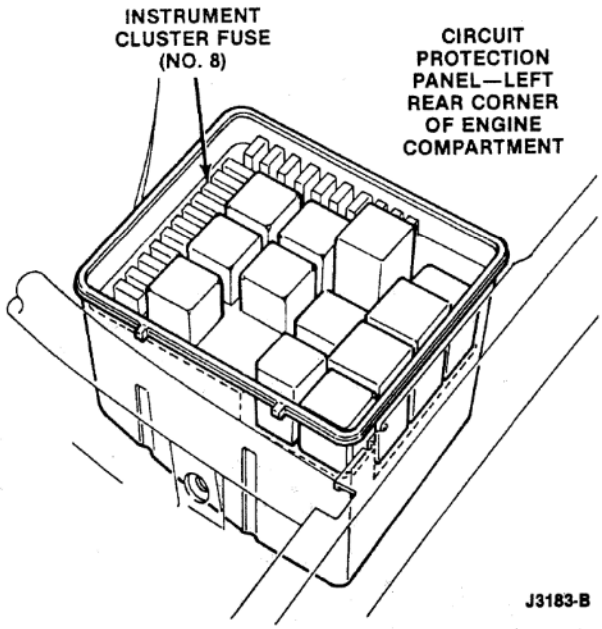
2. Disconnecting the D+ lead at the alternator should turn the charging system light off. If it doesn't, the D+ lead is grounded. Check for insulation damage.



CHARGING SYSTEM CHECKING

WARNING LIGHT FUNCTION CHECK (Continued)

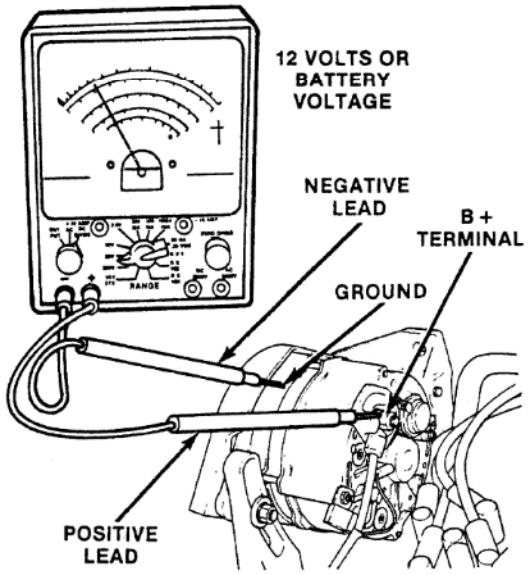
3. If the charging system warning light does not light when the key is turned ON, disconnect the D+ lead from the alternator and ground it. If the warning light comes on, the alternator field circuit is open. Check the brushes, slip ring, and regulator connections for good contact. If the warning light remains off with the D+ lead grounded, the D+ lead is open or the bulb is burnt out.
4. If none of the warning lights glow when the key is turned ON, the instrument cluster fuse is probably blown, but since this fuse also supplies the clock, windshield wipers, and interior lights, it is unlikely to be the primary cause of a charging system complaint.



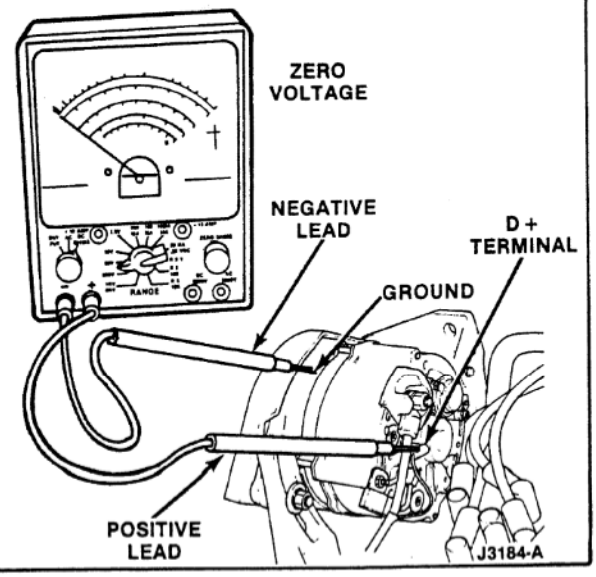
KEY-OFF CHECK

NOTE: For the following tests, charge the battery at or near full charge for accurate evaluation of charging system performance. If necessary, substitute a known, good battery.

1. With the ignition key OFF, check the voltage at the alternator B+ terminal. It should be battery voltage, approximately 12 volts. If not, the charging circuit between B+ and the battery positive post is open. Check for disconnects or wire damage.



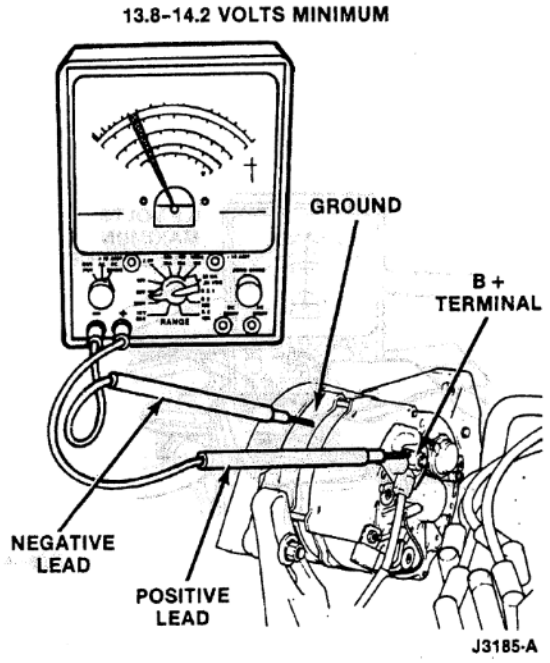
2. Check for voltage at the D+ terminal. If any voltage is present, it indicates a shorted positive output diode or diodes, which would reduce output and drain the battery, through the stator, field diodes, field and regulator to ground, even if not passing enough reverse current to damage system components.



CHARGING SYSTEM CHECKING

OUTPUT VOLTAGE CHECK

With the voltmeter connected between the B + terminal and ground, start the engine and run at about 1500 rpm while observing the output voltage. From the reduced start-up value, it should increase quickly as the starting load discharge is restored, and then stabilized. When stable, output voltage should be between 13.8 and 14.2 volts at 25°C (77°F), slightly lower at higher temperatures.

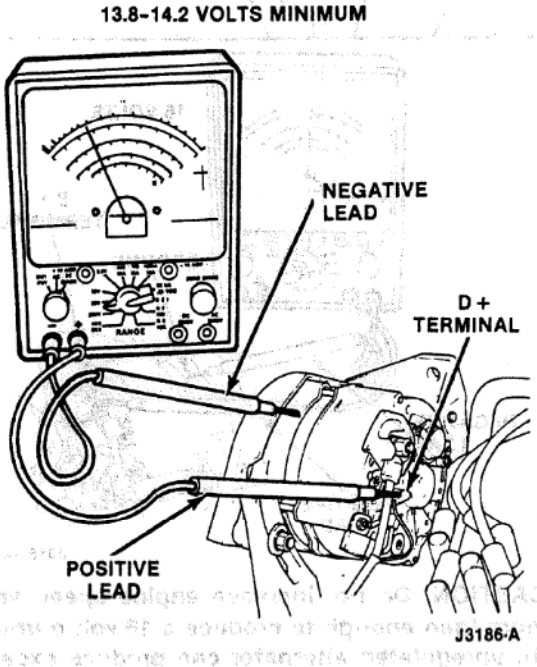


DIODE CHECK

Record the value of the output voltage at the B + terminal before stopping the engine, and then measure the voltage at the alternator D + terminal. It should be the same as the B + voltage within 0.5 volts. If the D + voltage is lower, it indicates a shorted or open field diode or diodes. In this case, a good regulator will try to increase field current to bring the sense voltage up to the required value. If the damaged diode(s) can pass enough field current, the alternator will overcharge.

NOTE: If the output voltage was high, indicating overcharging, and the field diodes test OK, the regulator is defective and should be replaced.

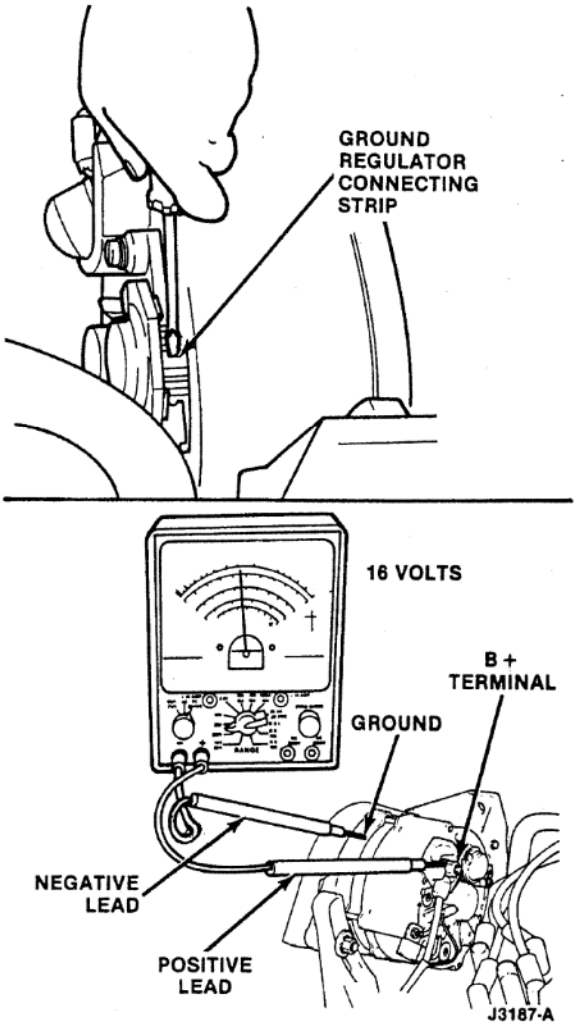
If the D + voltage is higher than B +, a defective output diode(s) is (are) indicated. If open, it will reduce output voltage while the regulator senses and responds to the higher D + voltage, causing the system to undercharge. A shorted positive output diode would have been detected in the key-OFF check. If the resistance of the shorted diode is low, the alternator and regulator may be severely damaged.



CHARGING SYSTEM CHECKING

REGULATOR BYPASS CHECK

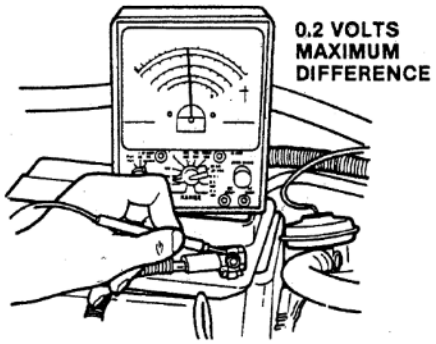
If the output voltage is low and there is no indication of defective diodes, start the engine and run at idle. While monitoring output voltage at the B+ terminal, ground the connecting strip between the rear brush and the regulator to the alternator frame, using a screwdriver or similar instrument. Increase engine speed gradually while observing the voltmeter. If output voltage can be increased to 16 volts, the regulator should be replaced. If not, the problem is probably in the alternator.



CAUTION: Do not increase engine speed any more than enough to produce a 16-volt output. An unregulated alternator can produce excessively high voltage at high speed.

EXTERNAL CIRCUIT CHECK

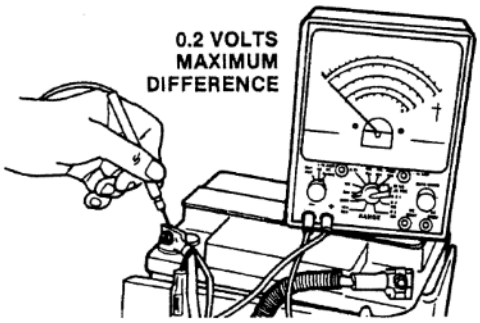
If output voltage tests normal, yet undercharge symptoms are reported, there may be excessive voltage drops in the circuit between alternator and battery. With the engine running at approximately 1500 rpm, check the output voltage at the alternator B+ terminal and at the battery positive post. If different by more than 0.2 volts, excessive resistance is present in the B+ circuit, due to loose or corroded connections or wire damage.



CHARGING SYSTEM

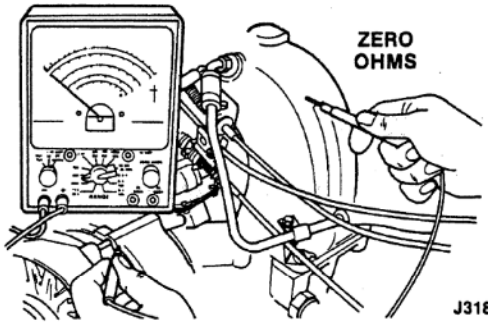
EXTERNAL CIRCUIT CHECK (Continued)

Similarly, check the battery ground cable for voltage between the battery negative post and the engine ground, using the voltmeter's low-voltage range. If a drop of more than 0.2 volts is detected, look for damage or poor connections in the ground cable.



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A similar check should be made between the alternator and engine ground, to detect excessive resistance in the alternator mounting.

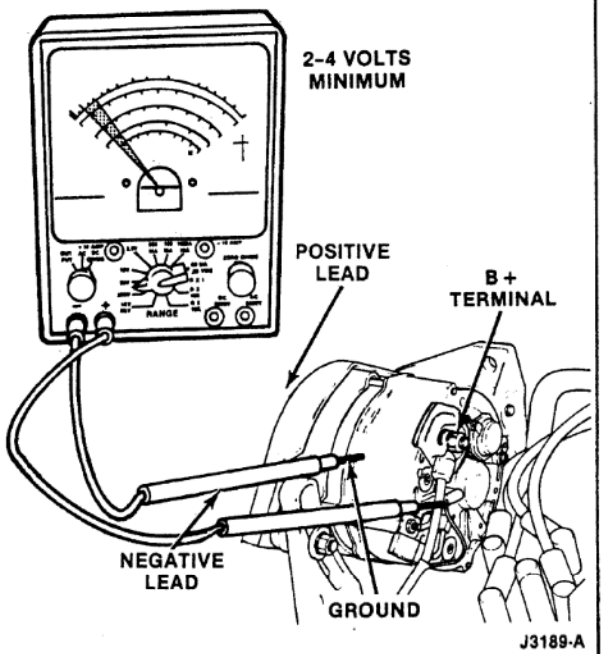


J3188-A

EXCITATION VOLTAGE CHECK

If no alternator output is apparent, that is, voltage does not increase above battery voltage with the engine running, stop the engine and check for voltage at the D+ terminal with the key ON. This is the initial excitation voltage for energizing the field at start-up, before alternator output is available to do the job, and should be in the 2- to 4-volts range.

If battery voltage is present, the field circuit is open. If it's between 4 volts and battery voltage, excessive resistance is present in the field circuit, either at the brush holder contact spring in the alternator end frame, between the brushes and slip rings, in the field winding, in the regulator, or at the regulator ground on the end frame. Release the drive belt tension and spin the rotor by hand while measuring the excitation voltage. If it fluctuates considerably but occasionally drops below 4 volts, the brushes and slip rings should be checked and cleaned, or replaced as necessary.

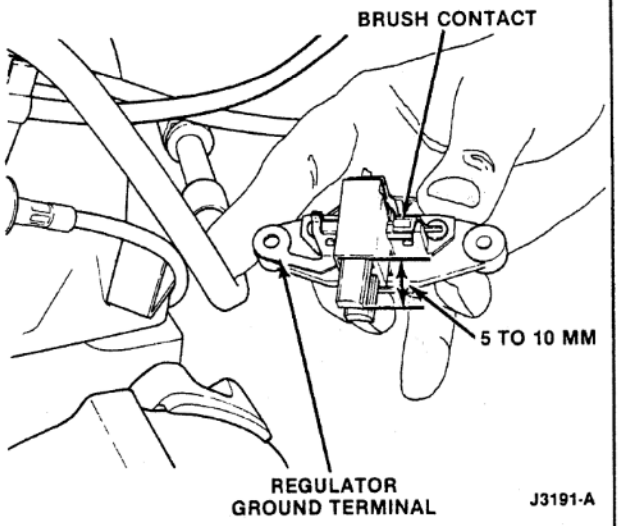


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CHARGING SYSTEM CHECKING

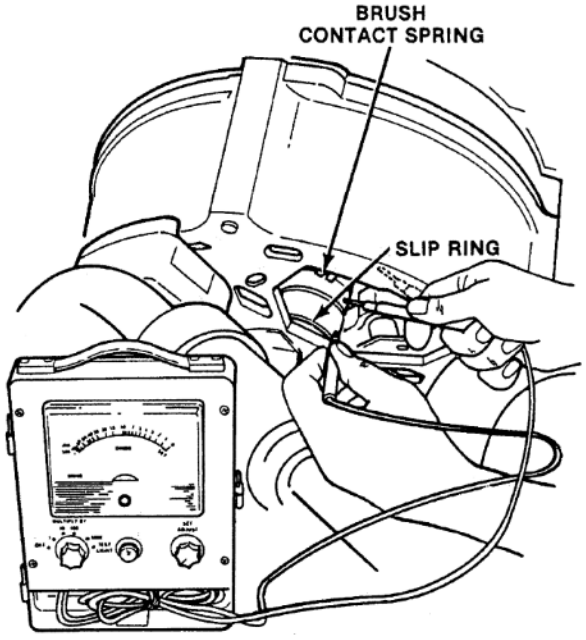
BRUSH CHECK

If spinning the rotor resulted in considerable variation in the excitation voltage, disconnect the battery ground cable, remove the regulator and brush holder assembly, and check the brushes for excessive wear or damage, bad connections, or sticky action. Brushes should project from the brush holder between 5 to 10 mm (5/32 to 3/8 in.). Clean and free up, or replace, the holder and regulator assembly. While the brush holder assembly is out, clean and polish the slip rings with crocus cloth or fine abrasive, spinning the rotor by hand with the drive belts loose. Check and clean the front brush contact on the brush holder, and the contact spring inside the alternator end frame. Also, be sure the regulator ground terminal makes good contact with the alternator end frame.



FIELD CHECK

While the brush holder assembly is out, check field coil continuity and isolation with an ohmmeter. Field coil resistance is in the area of 2 or 3 ohms, too small to measure reliably, but probing from slip ring to slip ring should indicate very low resistance unless the field is partially or completely open. Then probe from either slip ring to the alternator frame to verify that the field is not grounded (infinite ohms). Install the brush holder and regulator assembly, connect the battery ground cable and repeat the output voltage test.



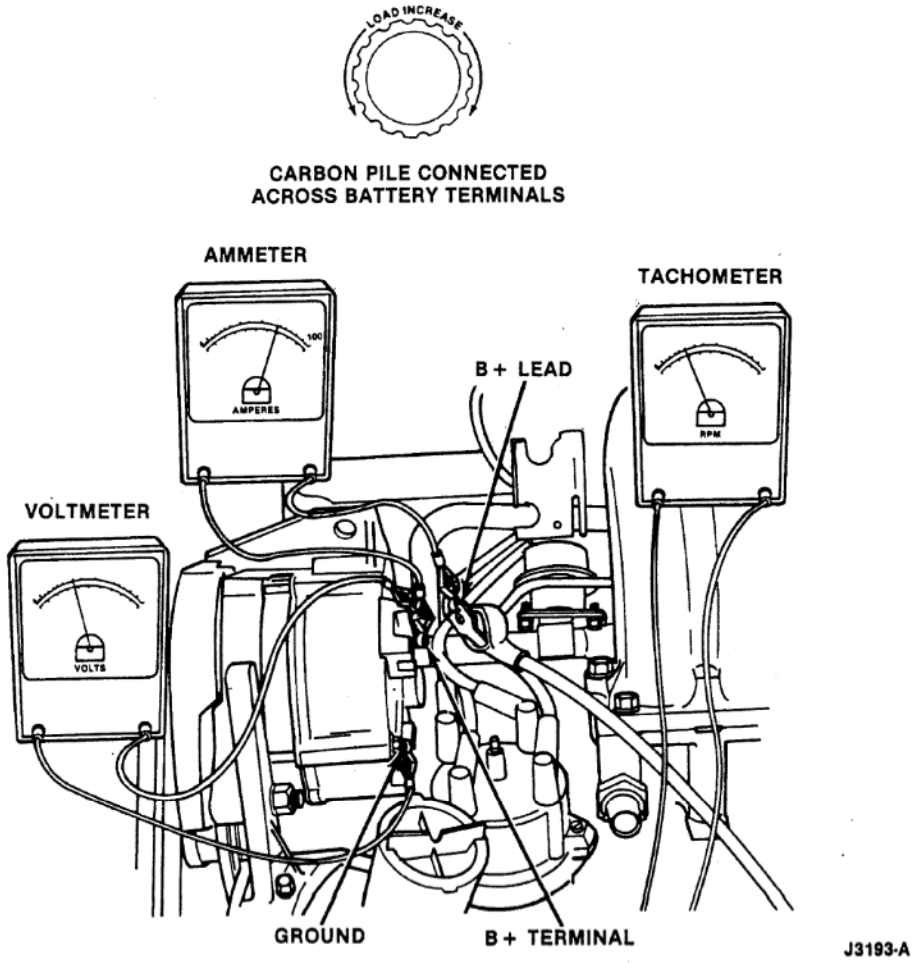
CHARGING SYSTEM CHECKING

OUTPUT CURRENT CHECK

If none of the foregoing checks indicated the cause of undercharging, it may result from partial shorts or opens in stator or field windings, or diodes breaking down under operating load conditions, limiting the output current. For the output current check, disconnect the battery ground cable and the alternator B+ lead. Connect a 100-amp ammeter between the B+ terminal and the end of the B+ lead, and position the B+ lead so that it cannot accidentally make contact with ground during the test. Connect a voltmeter between the B+ terminal and ground. Connect the battery ground cable and connect a carbon pile load rheostat across the battery terminals. **Be sure the carbon pile is turned to OFF or NO LOAD before connecting it.** Connect a tachometer, start the engine and run at idle. Adjust the carbon pile and engine speed until the voltmeter reads 13.5 volts at idle, and note the ammeter reading. Repeat the process at 1000 rpm, and at 2000 rpm. Compare the output current readings with the specifications in the following table:

ENGINE SPEED	OUTPUT CURRENT AT 13.5 VOLTS
Idle	28–35 amps
1000 rpm	75–85 amps
2000 rpm	89 amps

If alternator output is low, it must be removed and disassembled for further testing and repair. If necessary, refer to the procedures in Section 31-12.



SECTION 31-02 Batteries

SUBJECT	PAGE
DESCRIPTION	31-02-1
GENERAL SERVICE PROCEDURES	
Battery Charging	31-02-4
Cleaning	31-02-4
REMOVAL AND INSTALLATION	
Battery	31-02-2
Battery Replacement	31-02-2

DESCRIPTION

The storage battery is an electro-chemical device that converts electrical energy into chemical energy and stores this energy until electrical energy is once again needed. When the battery is connected to an electrical circuit, chemical energy is converted to electrical energy, and electric current flows through the circuit.

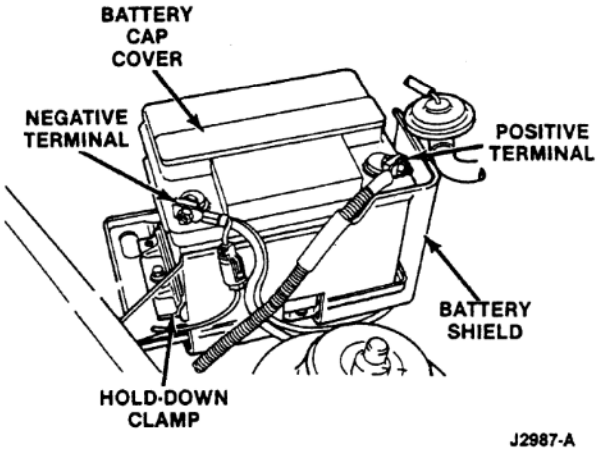
When the battery chemicals have been largely exhausted by discharging the battery, the battery can be recharged. This is done by passing an electric current through the battery from positive to negative, instead of from negative to positive, as in discharging. The charging process reverses the chemical action and restores the chemicals to where they were before discharge. Under normal conditions, the vehicle's charging system charges the battery.

The battery provides power to crank the engine and energize the vehicle ignition system in starting the engine. It also provides power for lighting and accessories when the engine (and alternator) are not running and acts as a voltage stabilizer in the charging system.

The battery is a low maintenance design. Battery caps are provided in the top of the battery for checking electrolyte level and state of charge. The battery cables should be inspected and, if necessary, cleaned during routine inspections and service. If necessary, refer to Section 31-01 for battery inspection and cleaning procedures.

CAUTION: Hydrogen and oxygen gases are produced during normal battery operation. This gas mixture can explode if flames, sparks or lighted tobacco are brought near the battery. When charging or using a battery in an enclosed space, always provide ventilation and shield your eyes.

WARNING: KEEP OUT OF REACH OF CHILDREN. BATTERIES CONTAIN SULFURIC ACID. AVOID CONTACT WITH SKIN, EYES OR CLOTHING. ALSO, SHIELD YOUR EYES WHEN WORKING NEAR THE BATTERY TO PROTECT AGAINST POSSIBLE SPLASHING OF THE ACID SOLUTION. IN CASE OF ACID CONTACT WITH SKIN, EYES, OR CLOTHING, FLUSH IMMEDIATELY WITH WATER FOR A MINIMUM OF FIFTEEN MINUTES. IF ACID IS SWALLOWED, DRINK LARGE QUANTITIES OF MILK OR WATER, FOLLOWED BY MILK OF MAGNESIA, A BEATEN EGG, OR VEGETABLE OIL. CALL A PHYSICIAN IMMEDIATELY.

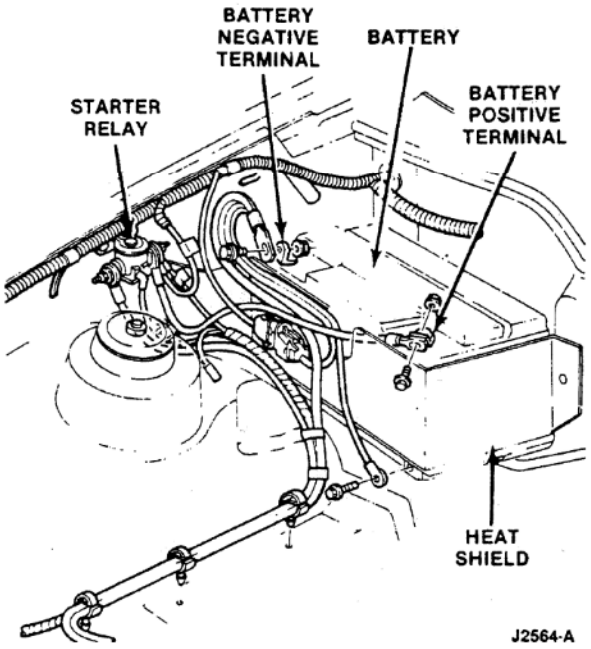


REMOVAL AND INSTALLATION

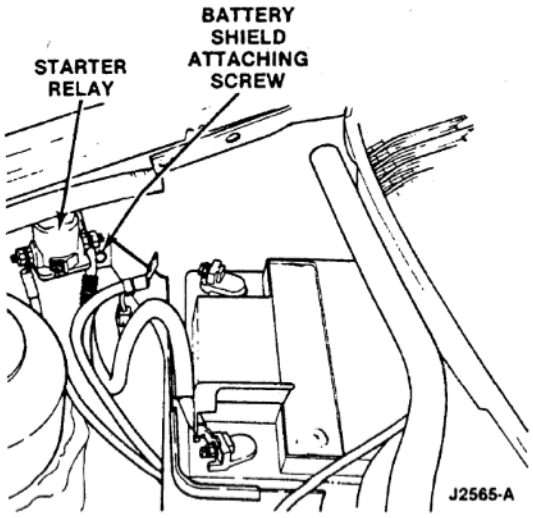
Battery

Removal

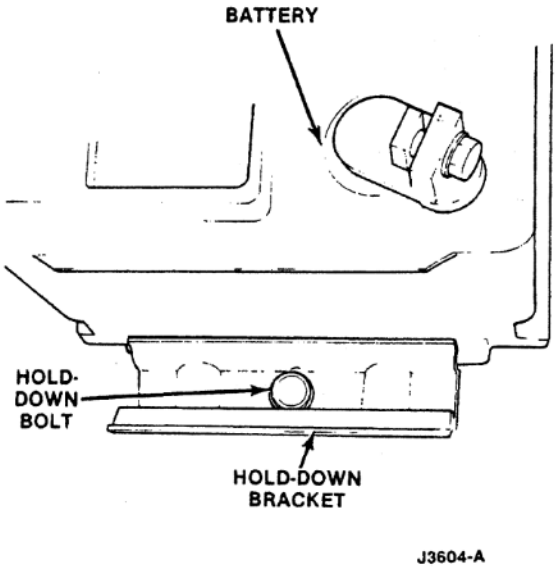
1. Disconnect the battery cables from the battery terminals, negative first.



2. Remove the left hand battery heat shield attaching screw and pull the shield away from the battery slightly.



3. Remove the battery hold-down bolt and hold-down bracket.



4. Carefully lift the battery out of the vehicle.

Installation

1. Place the battery in the vehicle.
2. Install the battery hold-down bracket and attaching bolt and tighten the bolt.
3. Install and tighten the left-hand battery heat shield attaching screw.
4. First, connect the positive, then the negative battery cable and tighten the attaching bolts.

Battery Replacement

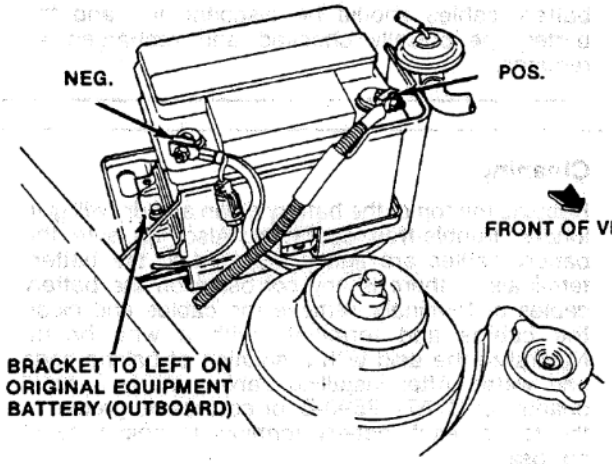
The battery installed in the XR4Ti at the time of manufacture is not available for service in North America. Whenever a battery requires replacement, the European top terminal battery will be replaced with a domestically available side terminal battery (BX-72 Motorcraft). The change in battery styles requires repositioning of the battery cables and hold-down.

REMOVAL AND INSTALLATION (Continued)

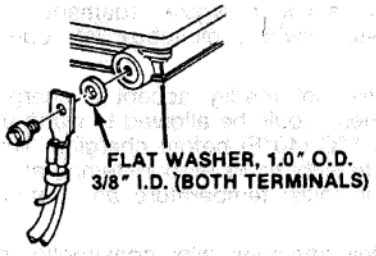
1. Remove the original equipment battery. If necessary, refer to the procedure in this Section.
2. Install the replacement battery in the battery tray, but position it on the outboard side of the battery tray (opposite from the original equipment battery).
3. Install the battery hold-down and tighten the attaching bolt until the battery is secure.

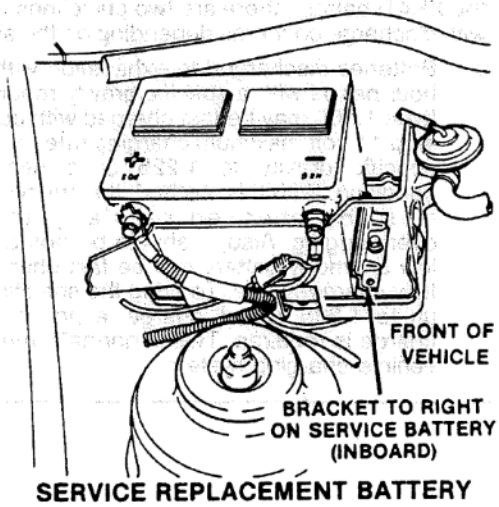
CAUTION: Before making the cable connections, note that the polarity of the replacement battery is reversed from the original equipment battery. Looking at the battery in the engine compartment, the positive cable connection will now be made on the left side.

4. Connect the positive battery cable noting the correct polarity. Tighten the attaching screw to 7 to 9 N·m (60 to 80 lb-in.).
5. Connect the battery negative cable and tighten the attaching screw to 7 to 9 N·m (60 to 80 lb-in.).
6. Position the battery heat shield and install the attaching screw.



ORIGINAL EQUIPMENT BATTERY





SERVICE REPLACEMENT BATTERY

J2986-A

GENERAL SERVICE PROCEDURES

Battery Charging

Before recharging a discharged battery in a vehicle, inspect and service the following conditions, if they exist:

1. Loose alternator belt.
2. Pinched or grounded alternator/voltage regulator wiring harness.
3. Loose connections at the alternator.
4. Loose or corroded connections at battery, starter relay and/or engine ground.
5. Excessive battery drain due to:
   a. Hood, decklid, glovebox and courtesy lamps remaining energized (damaged or misadjusted switch, glovebox left open, etc.).

Cold batteries will not readily accept a charge. Therefore, batteries should be allowed to warm up to approximately 5°C (40°F) before charging. This may require four to eight hours at room temperature depending on the initial temperature and battery size.

Because of the low antimony, alloy construction of the XR4Ti battery, there are two guidelines to follow with discharge concerns depending on the situation:

a. Batteries discharged to exhaustion within a 24 hour period with a specific gravity reading of at least 1.100 may be fast charged with up to a 30 amp 14 volt maximum charging rate to raise the specific gravity to 1.225 or a serviceable condition. With this method, the specific gravity must be checked regularly to avoid overcharging. Also, it should be noted that no low antimony battery can be fast charged to a fully charged state. To bring the specific gravity up to 1.265, or full charge, a period of slow charge is required. This is normally met by the vehicle charging system.

b. Batteries discharged to a specific gravity reading below 1.100, or batteries discharged below 1.225 over a long time period (vehicles stored for several weeks) must be charged slowly with a voltage of 12 to 14 volts and a maximum of 2 amps until the specific gravity reading reaches 1.265. In some cases, when the battery appears to be completely exhausted, it may take from 2 to 6 hours before a 1.100 reading is obtained and 24 to 30 hours to reach 1.265.

   NOTE: In any of the above situations, if there is a 50 point (0.050) or more variation between cells when checking specific gravity, discontinue charging and replace the battery.

Generally, a vehicle with a fully charged battery can be stored with the cables connected at 80°F for about four weeks. At 116°F, a battery self-discharges about four times as fast as at 80°F. If vehicles are to be stored under these conditions, the battery cables should be disconnected and the battery periodically checked and recharged as required.

Cleaning

Keeping the top of the battery clean and dry will give longer, trouble-free operation. Also, be sure the battery cables are tightly fastened to the battery terminals. If there is any corrosion on the battery cables or terminals, remove the cables and clean the cables and terminals with a wire brush. Neutralize the acid with a solution of baking soda and water. After installing cables, apply a small quantity of C1AZ-19590-B, or equivalent, grease to the top of each battery terminal to help prevent corrosion.

GENERAL SERVICE PROCEDURES

BATTERY CHARGING (Continued)

- The **second method** is to use the "manual" or constant current setting on the charger. Initially set the harging rate for 30-40 amps and maintain this setting for approximately 30 minutes or as long as there is no excessive gassing and electrolyte spewing. If gassing results, the charge rate must be reduced to a level where gassing will stop.

The total charge required will vary with the battery size and its initial state of charge. In general, to bring a discharged battery to a serviceable state of charge, the current-time input should equal the battery amp-hour capacity. For example: a 45 AH battery with a reserve capacity of 75 minutes will require 15 amps of charge for three hours, or 9 amps of charge for five hours. Again, if a full state of charge is desired, the charge can be completed by a low constant current of 3-5 amps for several hours.

If the battery has failed, or is low in charge, it may be necessary to refer to Diagnosis, Section 31-01.

CLEANING

Keeping the top of the battery clean and dry will give longer, trouble-free operation. Also, be sure the battery cables are tightly fastened to the battery terminals. If there is any corrosion on the battery cables or terminals, remove the cables and clean the cables and terminals with a wire brush. Neutralize the acid with a solution of baking soda and water. After installing cables, apply a small quantity of C1AZ-19590-B, or equivalent, grease to the top of each battery terminal to help prevent corrosion.

SECTION 31-12 ALTERNATOR

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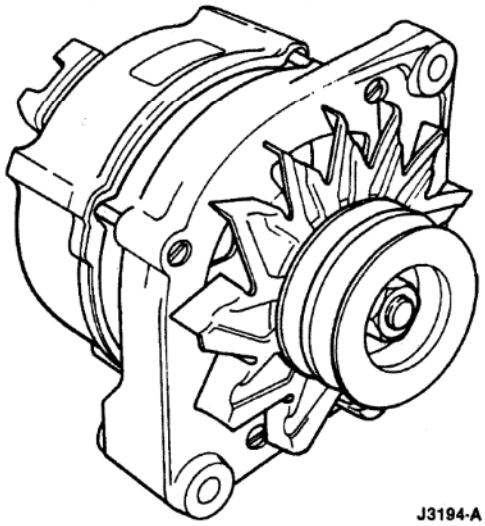
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- Drive Belt Tension 2

REMOVAL AND INSTALLATION
- Drive Belts 3
- Alternator 3
- Voltage Regulator 4

DISASSEMBLY AND ASSEMBLY
- Alternator 5

COMPONENT INSPECTION CHART 10

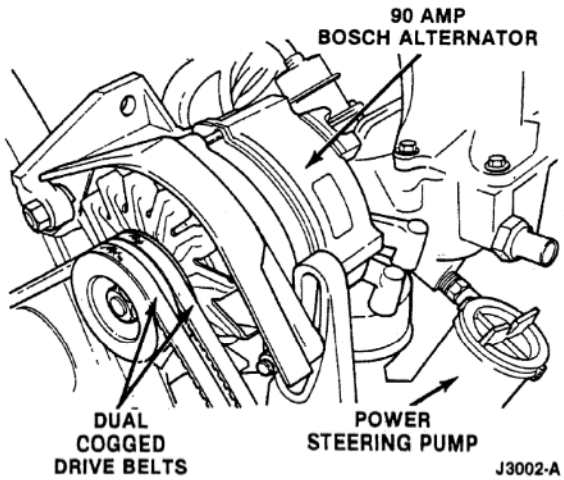
COMPONENT TEST CHART 11



J3194-A

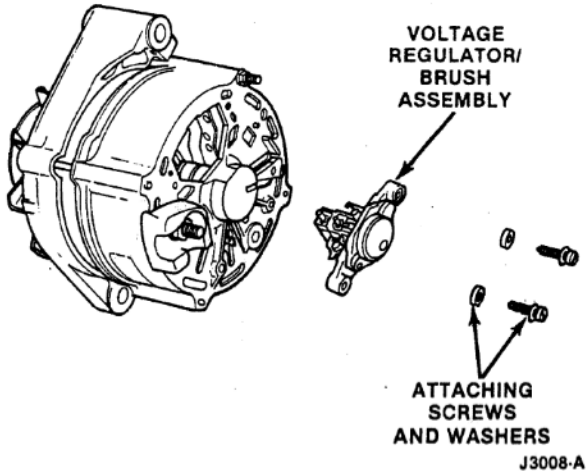
DESCRIPTION

The alternator is a 90 amp Bosch model. It is driven by dual cogged belts and is mounted above the power steering pump on the left side of the engine.



J3002-A

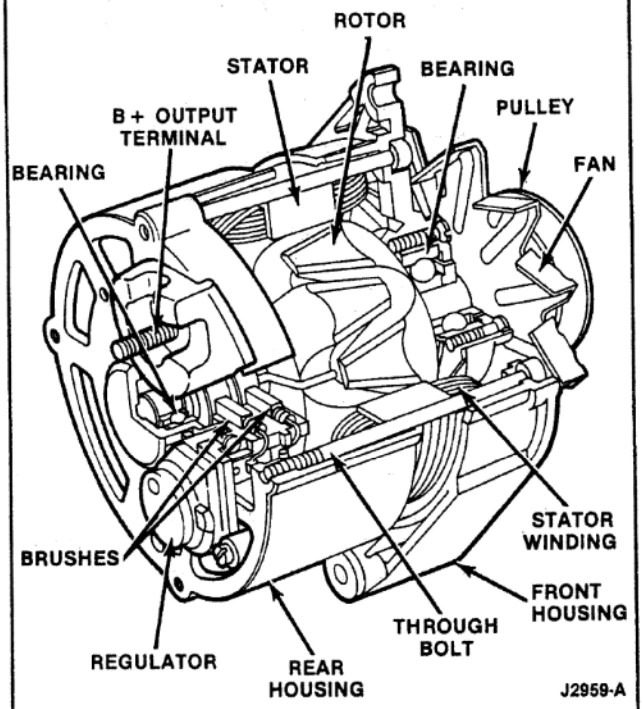
The electronic voltage regulator is mounted on the back of the alternator with two attaching screws. The regulator and brush set are a single assembly.



J3008-A

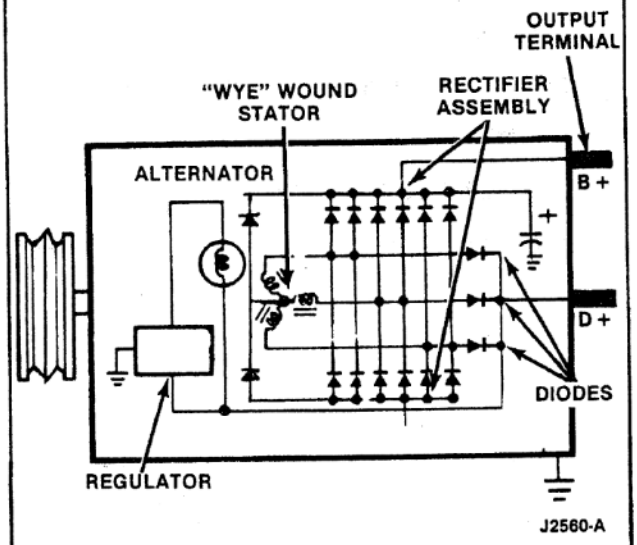
DESCRIPTION

The alternator is a conventional design with the rotor magnetic field spinning within the stationary stator windings. The rotor is supported in the housing on ball bearings which are pressed onto the shaft. Field current is supplied through the brush set that rides against the rotor slip rings. The cooling fan and pulley are attached to the rotor shaft with a nut and lock washer. The rotor bearings and stator are supported in a two-piece housing joined by four through bolts.



Because the voltage induced in the "Wye" wound stator produces alternating current, a rectifier assembly is installed between the stator and alternator output terminal. The rectifier assembly contains six positive and six negative silicon diodes that allow only the positive side of the alternating current to reach the alternator output terminal. The three-phase stator windings and rectifier assembly eliminate the pulsating AC current to produce a steady, positive DC current.

A set of three diodes is connected to the D+ terminal. These diodes help supply field current to the rotor after the alternator is up to operating speed.



ADJUSTMENTS

DRIVE BELT TENSION

Refer to Section 27-02 for the drive belt adjustment procedure.

REMOVAL AND INSTALLATION

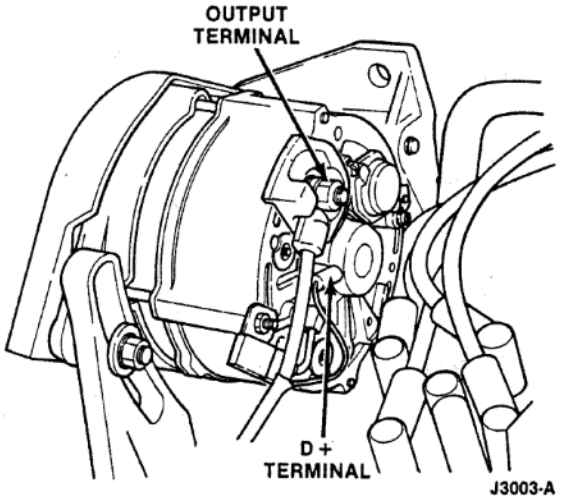
DRIVE BELTS

Refer to Section 27-02 for the drive belt replacement procedure.

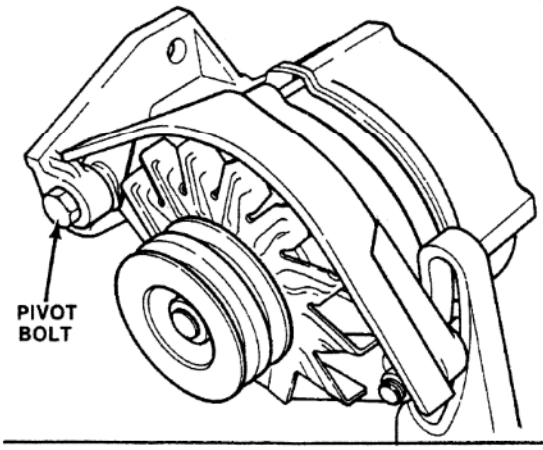
ALTERNATOR

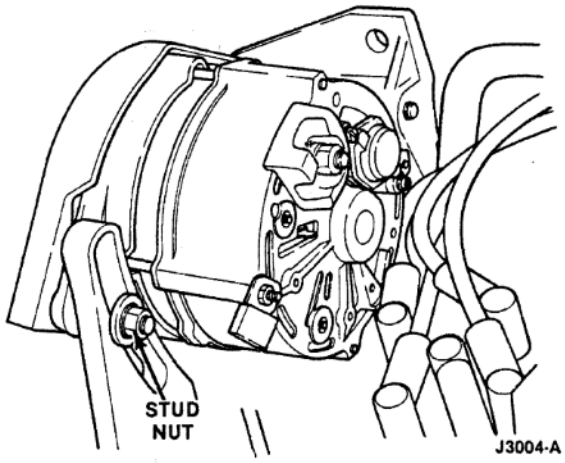
Removal

1. Disconnect the battery negative cable.
2. Loosen the alternator drive belt adjusting bolts. Pivot the alternator downward and remove the drive belts from the pulley. If necessary refer to Section 27-02.
3. Disconnect the wiring from the alternator output terminal and D+ terminal.



4. Remove the alternator attaching bolts and the alternator.





Installation

1. Position the alternator on the mounting bracket and install the attaching bolts.
2. Connect the wiring to the alternator output terminal and D+ terminal.
3. Position the drive belts over the alternator pulley and adjust to the specified tension. If necessary, refer to Section 27-02.
4. Connect the battery negative cable.

REMOVAL AND INSTALLATION

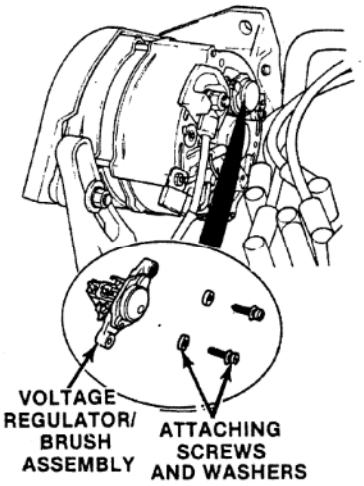
VOLTAGE REGULATOR

Removal

1. Disconnect the battery negative cable.
2. Remove the voltage regulator attaching screws and the regulator.

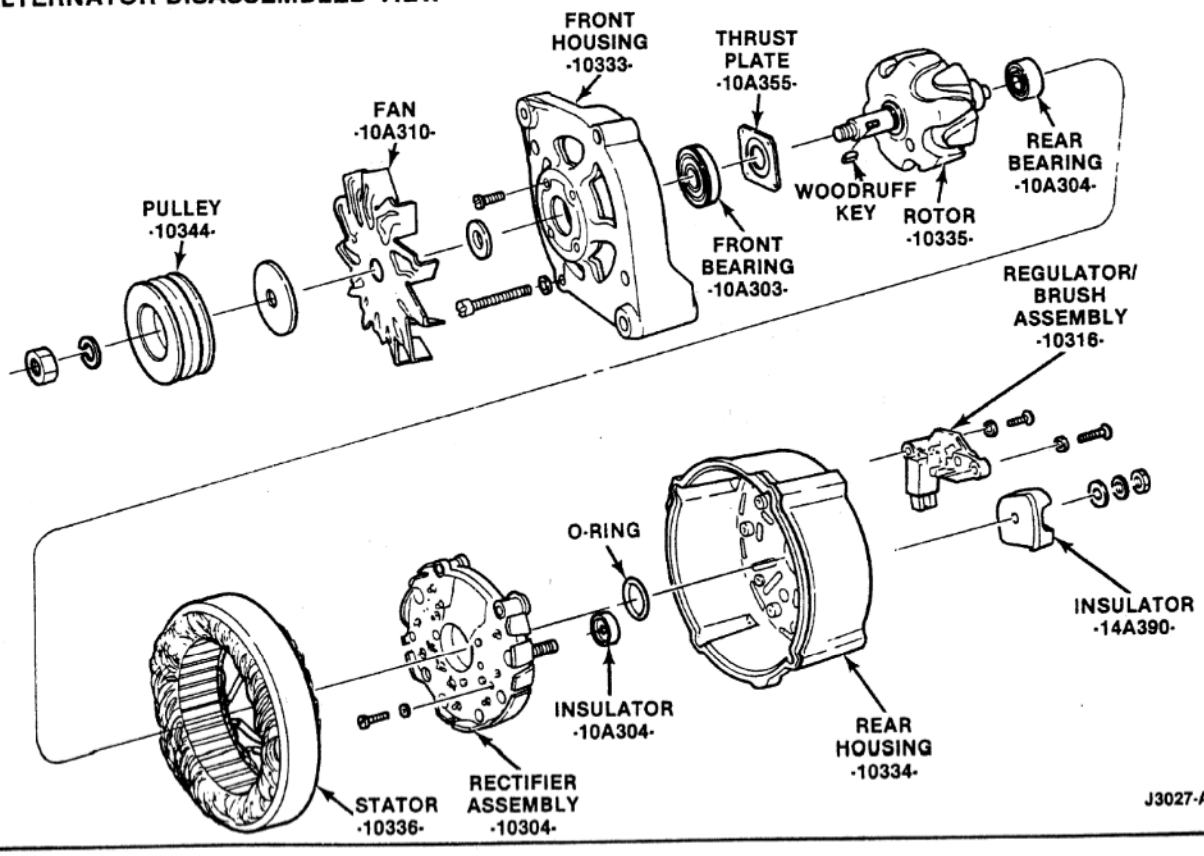
Installation

1. Install the voltage regulator.
2. Hold the regulator in position against the brush spring tension and install the attaching screws.
3. Connect the battery negative cable.



DISASSEMBLY AND ASSEMBLY

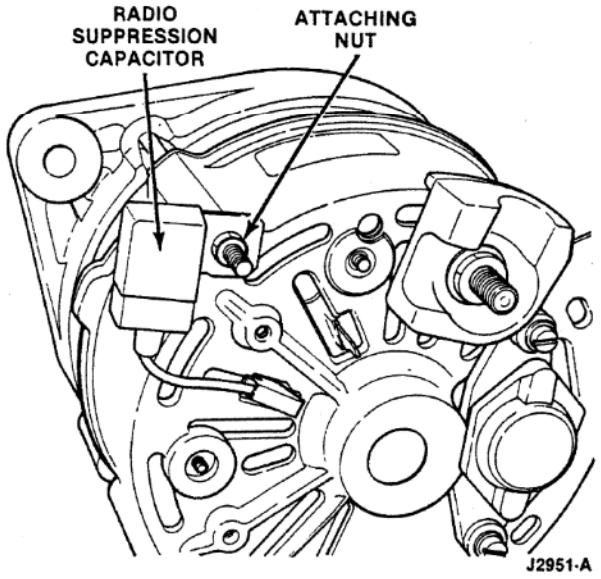
ALTERNATOR DISASSEMBLED VIEW



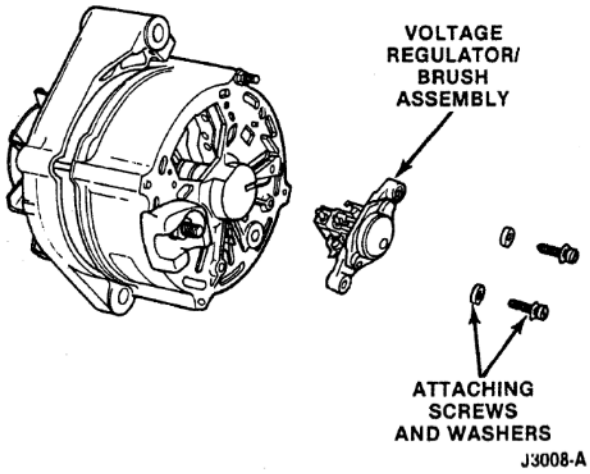
DISASSEMBLY AND ASSEMBLY

Disassembly (Continued)

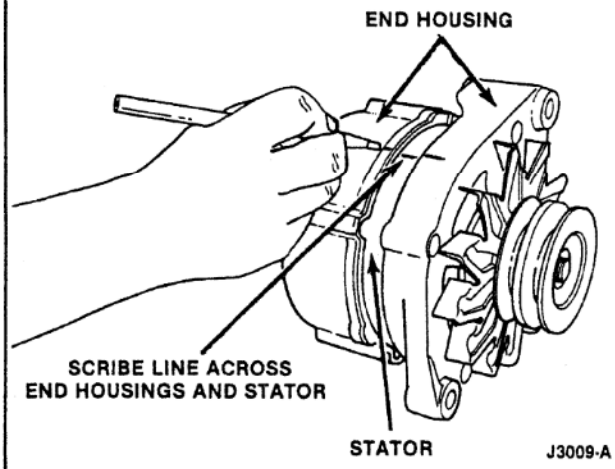
1. Remove the radio suppression capacitor.



2. Remove the voltage regulator/brush assembly.



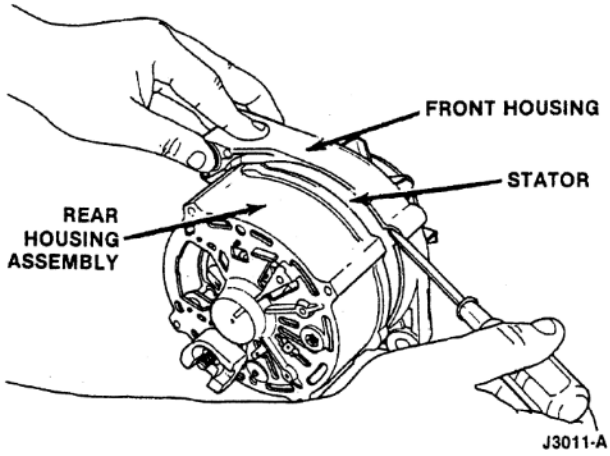
3. Scribe a line across the end housings and stator for alignment reference during assembly.



4. Remove the four housing through bolts.

5. Separate the front housing and rotor assembly from the stator and rear housing assembly.

NOTE: Stator must remain with rear housing assembly to avoid damaging stator leads.

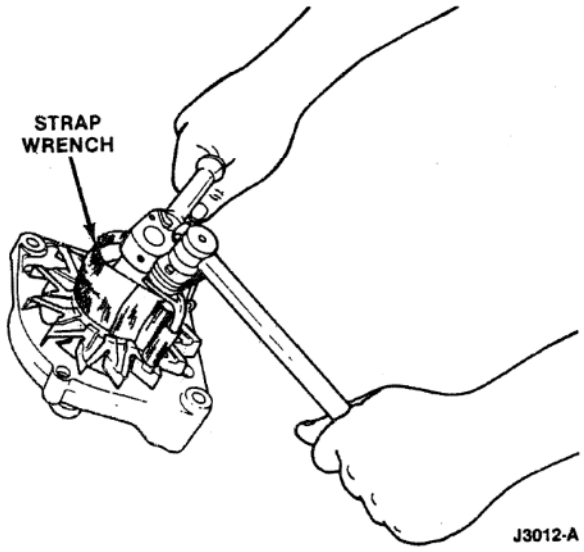


If necessary, carefully pry the front housing from the stator frame using a screwdriver.

DISASSEMBLY AND ASSEMBLY

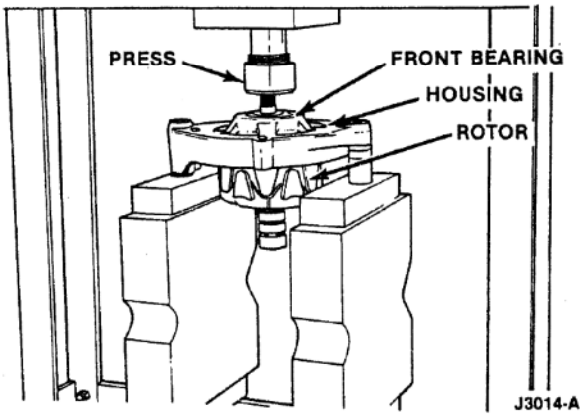
Disassembly (Continued)

6. Remove the drive pulley attaching nut.

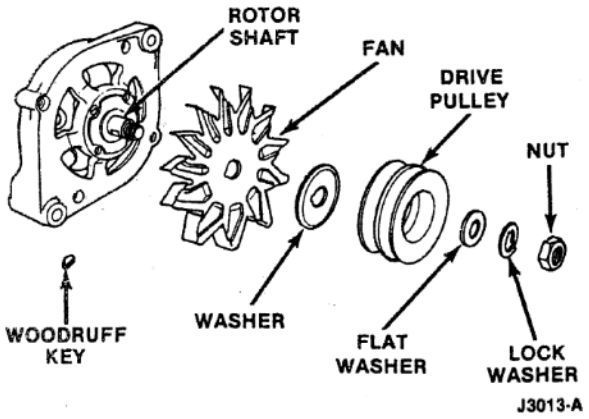


A strap wrench can be used to hold the pulley during removal of the pulley attaching nut.

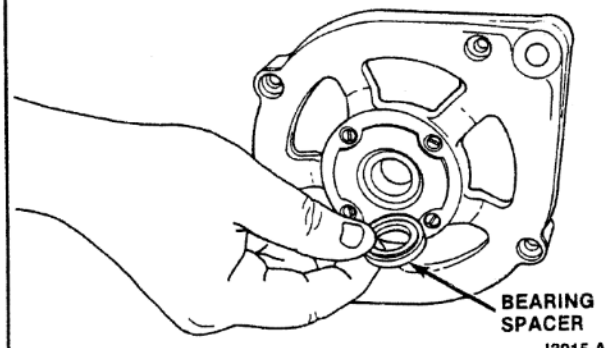
8. Remove the rotor from the front bearing and housing using a suitable press.



7. Remove the drive pulley, washer, fan and woodruff key from the rotor shaft.



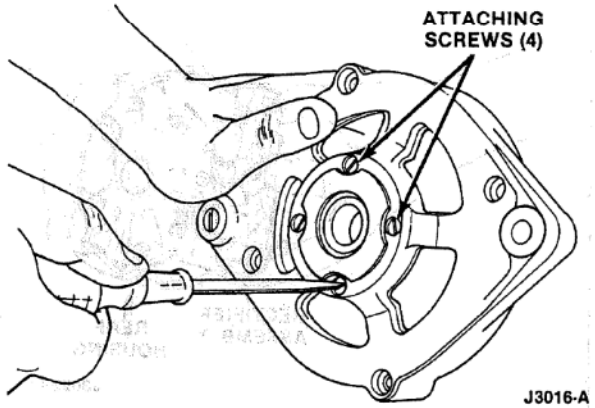
9. Remove the bearing spacer from the front of the housing.



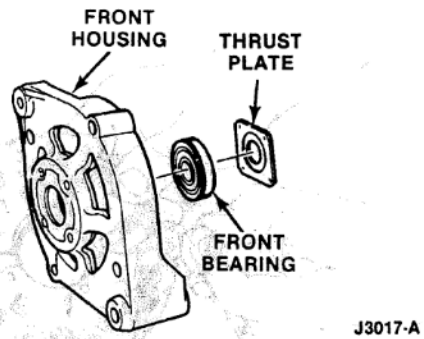
DISASSEMBLY AND ASSEMBLY

Disassembly (Continued)

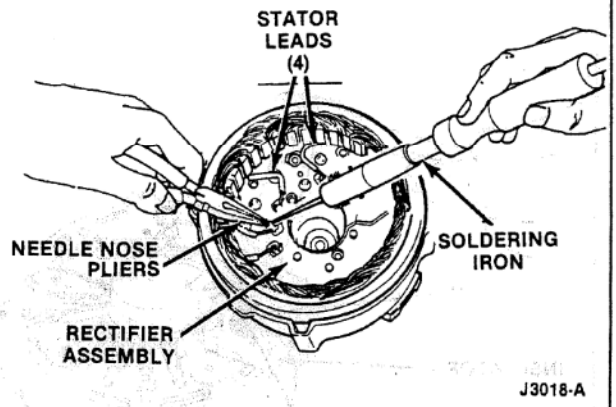
10. Remove the front bearing thrust plate attaching screws.



11. Remove the front bearing and thrust plate from the housing.

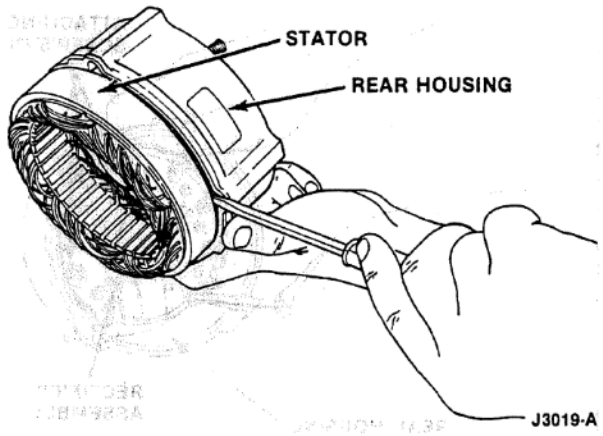


12. Using a 100-watt soldering iron, unsolder the stator leads from the rectifier assembly.



NOTE: Do not allow the soldering iron to overheat the diodes. Needle nose pliers clamped to the diode lead can be used as a heat sink to absorb heat which would otherwise damage the diodes.

13. Remove the stator from the rear housing.

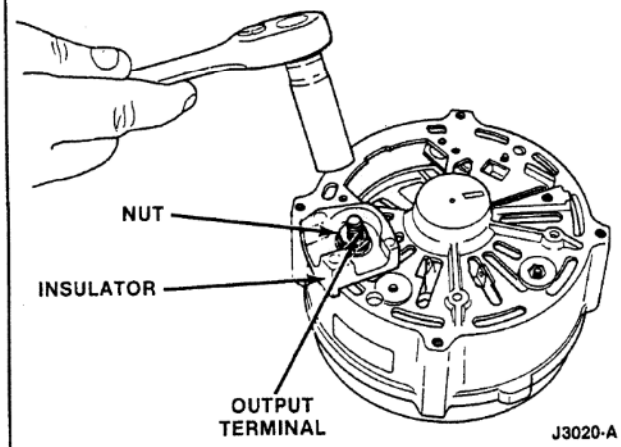


If necessary, carefully pry the stator out of the housing using a screwdriver.

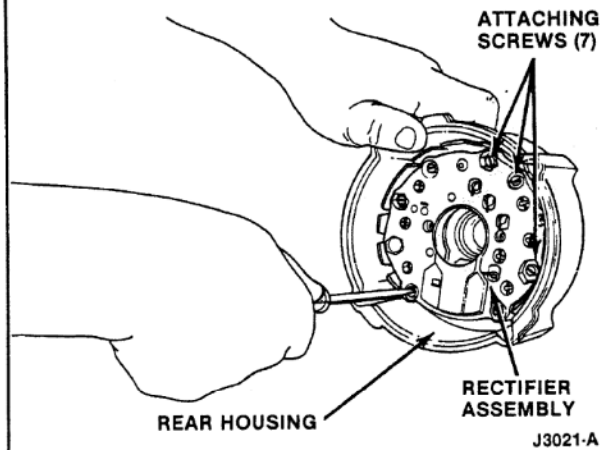
DISASSEMBLY AND ASSEMBLY

Disassembly (Continued)

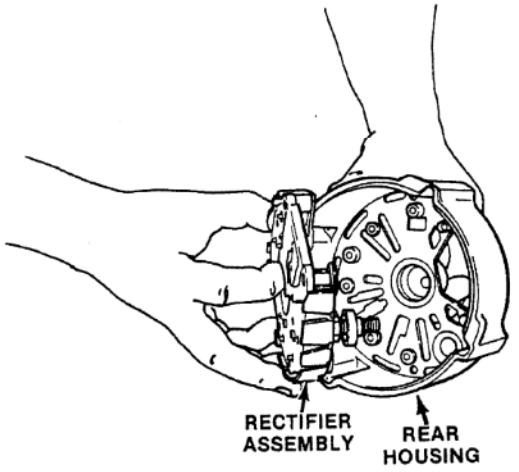
14. Remove the nut and insulator from the output terminal.



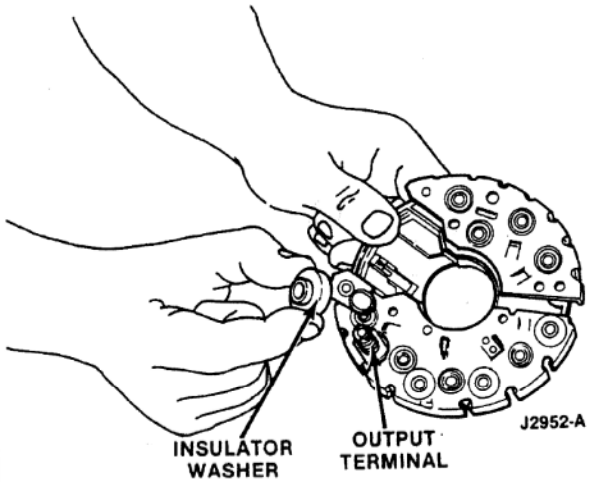
15. Remove the screws attaching the rectifier assembly to the rear housing.



16. Remove the rectifier assembly from the rear housing.



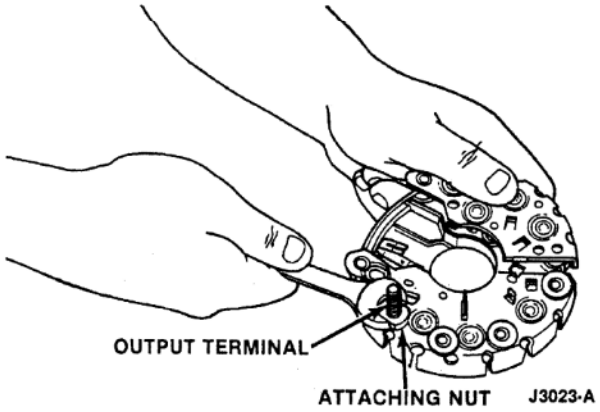
17. Remove the insulator washer from the output terminal.



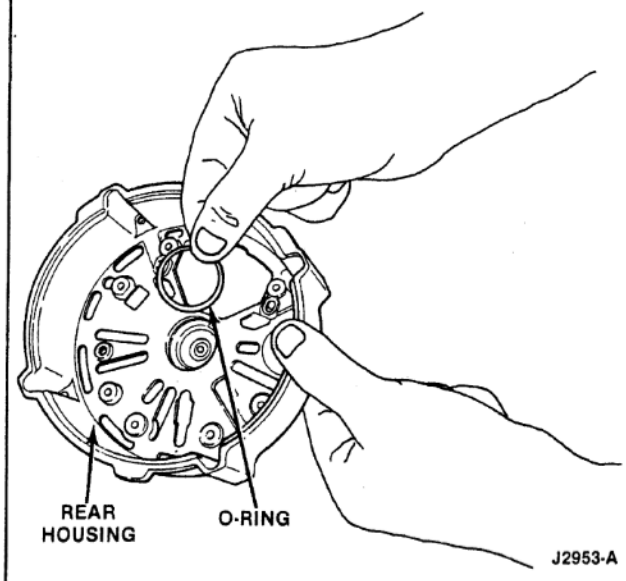
DISASSEMBLY AND ASSEMBLY

Disassembly (Continued)

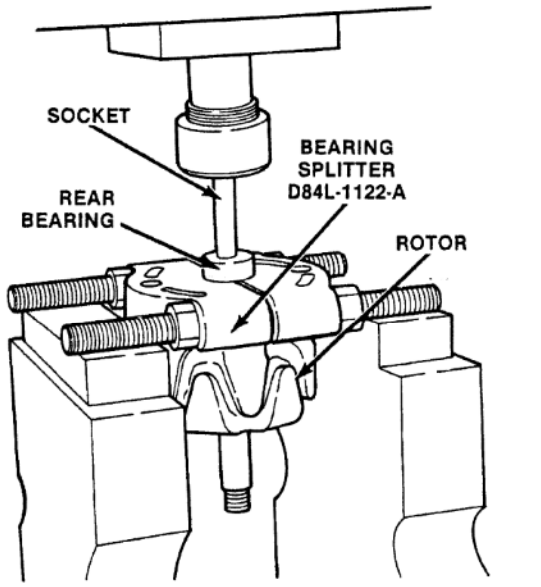
18. Remove the output terminal attaching nut. Then, remove the output terminal from the stator assembly.



19. Remove the O-ring seal from the rear housing.



20. Remove the rear bearing from the rotor shaft using Bearing Splitter D84L-1122-A, or equivalent.



DISASSEMBLY AND ASSEMBLY

ALTERNATOR

COMPONENT INSPECTION CHART

NOTE: Clean all parts thoroughly before inspecting. **Do not** wash the rotor, stator regulator, rectifier or bearings in cleaning solvent.

COMPONENT	CHECK FOR
ROTOR	• Stripped or damaged at pulley end • Damaged or enlarged woodruff key slot • Scored bearing surfaces indicating the bearing has spun on the shaft • Scuff marks on the pole fingers indicating a bent shaft which allows the rotor to rub against the stator frame • Dirty or contaminated slip rings — Slip rings can be cleaned using a No. 400 silicon carbide paper and finish polished using crocus cloth (DO NOT USE EMERY PAPER). The best cleaning method is to spin the rotor in a lathe or drill press to prevent flat spots.
STATOR	• Burned or discolored windings indicating insulation breakdown from excessive heat • Scuff marks on the inside of stator frame indicating a bent rotor shaft • Damage to the stator frame
HOUSINGS	• Cracked or damaged mountings • Scoring in the bearing bores indicating the bearings have spun in the housing • Lubricant in the bearing bores indicating damaged bearings
DRIVE PULLEY	• Bent, broken or cracked pulley groove • Wear or damage to the pulley key slot which could prevent a tight fit on the shaft
BRUSHES	• Burn spots or discoloration indicating arcing • Dirt or contamination • Wear — If brush length is less than 5 mm (3/8 in.), replace the brushes

CJ3195-A

DISASSEMBLY AND ASSEMBLY

ALTERNATOR
COMPONENT INSPECTION CHART (Continued)

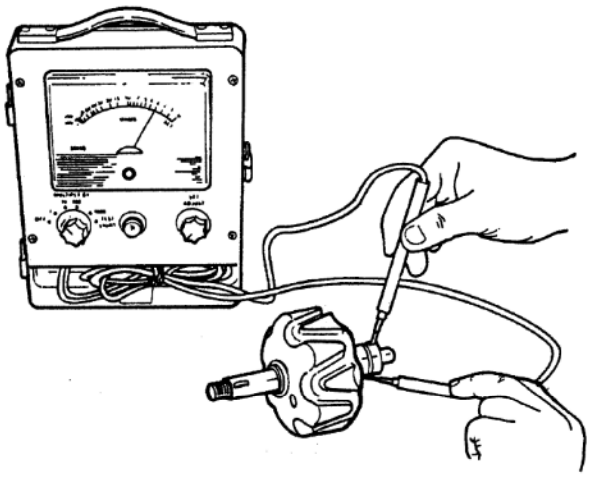
COMPONENT	CHECK FOR
BEARINGS	• Roughness or flat spots — To determine this condition, slowly rotate the bearing on the shaft or between fingers. A flat spot will appear as a sudden tightening and then loosening of the outer race. Roughness will have a general uneven feel as the bearing is rotated. • Leakage of lubricant past the bearing seals • Scoring on the inner or outer races, indicating the bearing has spun on the shaft or in the housing

CJ2562-A

ALTERNATOR

COMPONENT TEST CHART

TEST	TEST RESULTS
ROTOR COIL RESISTANCE Set the ohmmeter on the ×1 scale and connect the meter leads across the rotor slip rings.	• 3.0 ohms: Rotor coil is OK. If the coil resistance is above or below 3.0 ohms, replace the rotor.

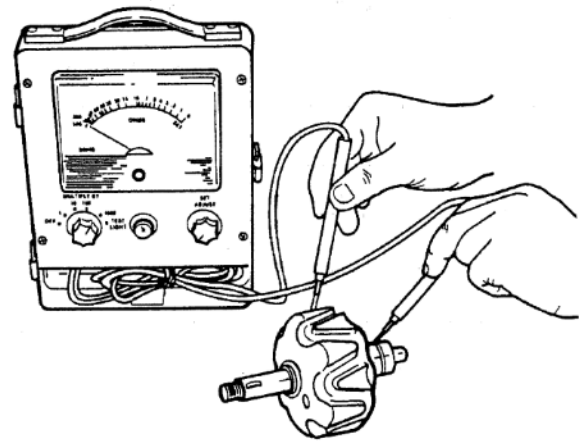


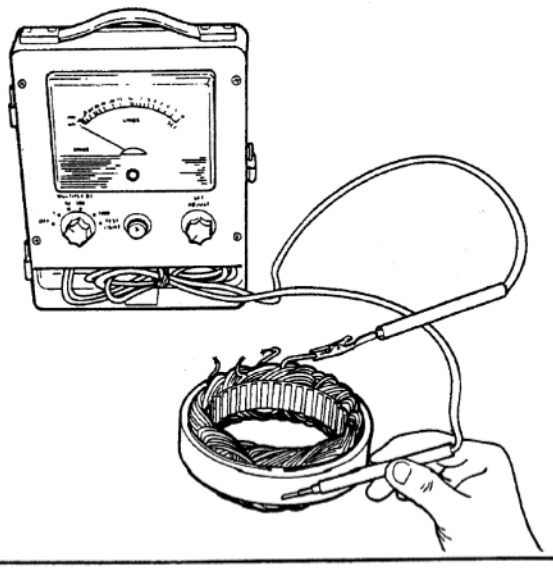
CJ3196-A

DISASSEMBLY AND ASSEMBLY

ALTERNATOR
COMPONENT TEST CHART (Continued)

TEST	TEST RESULTS
GROUNDED ROTOR COIL Set the ohmmeter on the ×1 scale. Touch one meter lead to a rotor slip ring and the other meter lead to one of the rotor poles.	• Infinite: Rotor coil is OK. • Continuity: Rotor coil is grounded. Replace rotor assembly.
GROUNDED STATOR WINDINGS Set the ohmmeter on the ×1 scale. Clip one meter lead to a stator lead. Touch the other meter lead to the stator frame.	• Infinite resistance: Rotor coil is OK. • Continuity: Rotor windings are grounded. Replace the stator.



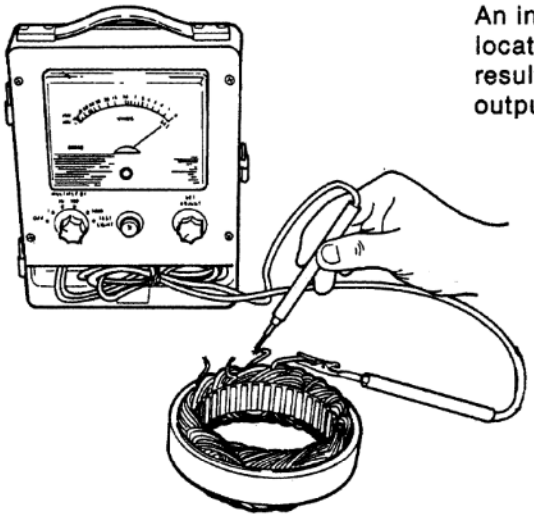


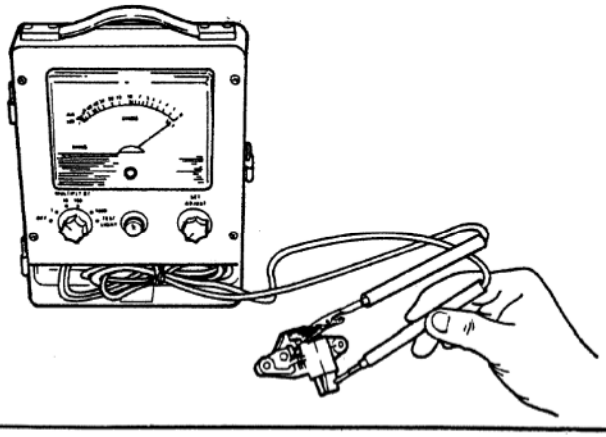
CJ3197-A

DISASSEMBLY AND ASSEMBLY

ALTERNATOR
COMPONENT TEST CHART (Continued)

TEST	TEST RESULTS
OPEN STATOR WINDINGS Set the ohmmeter on the ×1 scale. Clip one of the meter leads to a stator lead. Touch the other meter lead to the remaining three stator leads.	• Continuity in all three positions: Stator windings are OK. • Infinite resistance in any one of the three positions indicates an open stator winding. Replace the stator. **NOTE:** SHORTED STATOR WINDINGS An internal short between adjacent windings is difficult to locate without laboratory equipment. If all other alternator test results are normal and the alternator fails to supply the rated output, shorted stator windings are probable.
BRUSH CIRCUIT CONTINUITY Set the ohmmeter on the ×1 scale. Touch one meter lead to the brush and the other meter lead to the brush terminal. Check the inner and outer brush using this method.	• Continuity in both positions: Brush circuits are OK. • Infinite resistance in either position: Brush circuit is open. Replace the brush and regulator as an assembly.



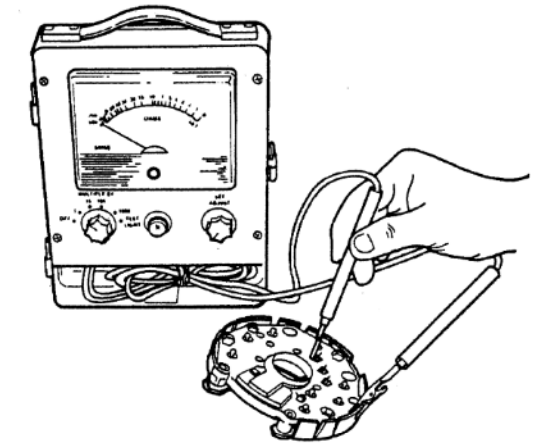


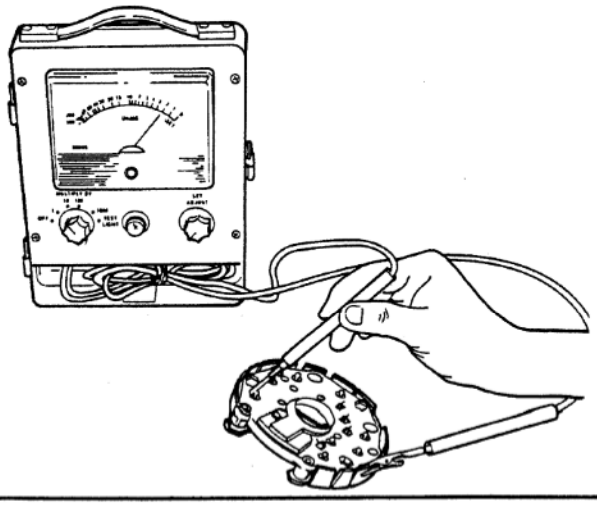
CJ3198-A

DISASSEMBLY AND ASSEMBLY

ALTERNATOR
COMPONENT TEST CHART (Continued)

TEST	TEST RESULTS
NEGATIVE RECTIFIERS Set the ohmmeter on the ×1 scale. Clip one meter lead to the negative diode heat sink. Touch the other meter lead to each negative rectifier pin. Reverse the ohmmeter leads and make the same check.	• Continuity in one direction only: Negative diodes are OK. • Continuity in both directions on any one rectifier: Rectifier is shorted. Replace the rectifier assembly. • No continuity in either direction on any one rectifier: Rectifier is open. Replace the rectifier assembly.
POSITIVE RECTIFIERS Set the ohmmeter on the ×1 scale. Clip one meter lead to the positive diode heat sink. Touch the other meter lead to each positive rectifier pin. Reverse the ohmmeter leads and make the same check.	• Continuity in one direction only: Positive diodes are OK. • Continuity in both directions on any one rectifier: Rectifier is shorted. Replace the rectifier assembly. • No continuity in either direction on any one rectifier: Rectifier is open. Replace the rectifier assembly.





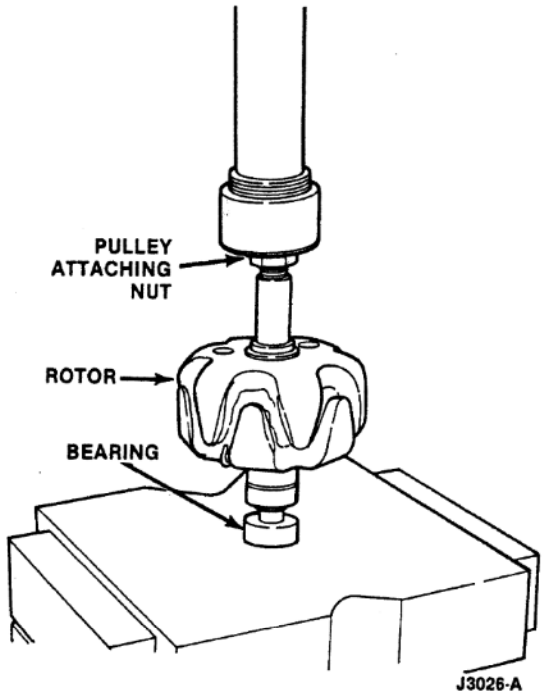
CJ3199-A

DISASSEMBLY AND ASSEMBLY

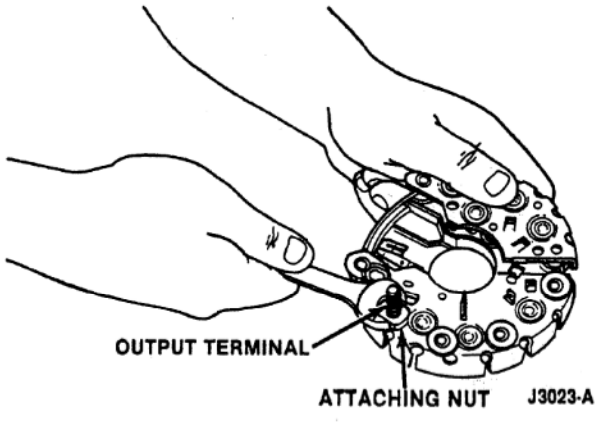
ALTERNATOR

Assembly

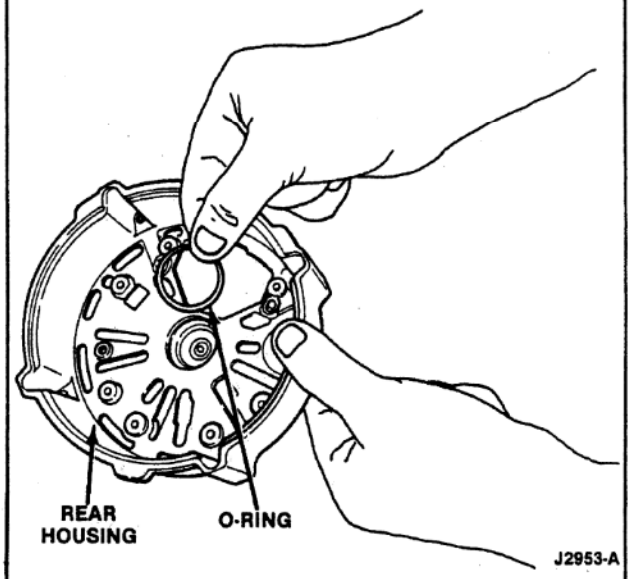
1. Install the rear bearing using a suitable press.



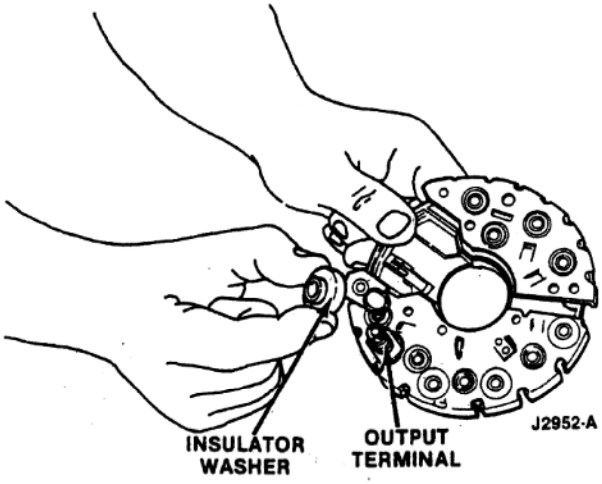
2. Install the output terminal in the rectifier assembly and secure with the attaching nut.



3. Install the O-ring seal in the rear housing.



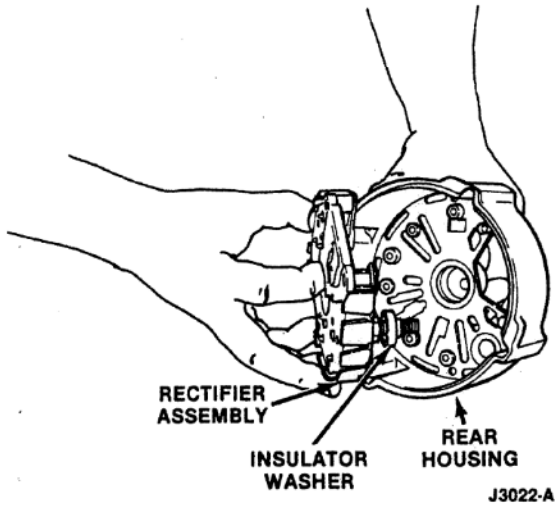
4. Install the insulator washer on the output terminal.



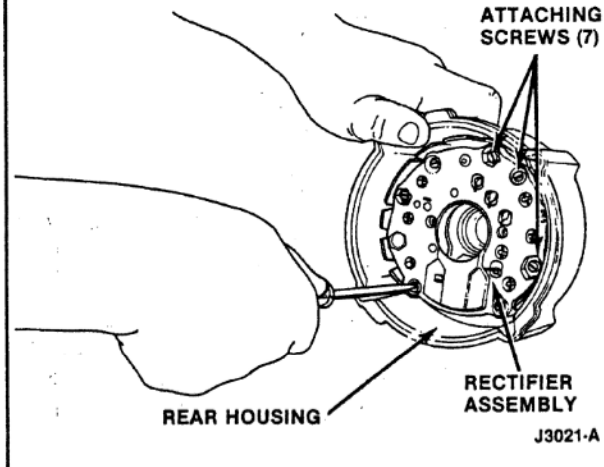
DISASSEMBLY AND ASSEMBLY

Assembly (Continued)

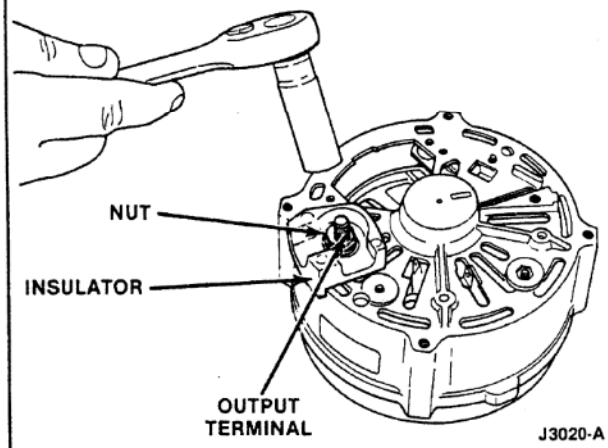
5. Install the rectifier assembly in the rear housing.



6. Install the rectifier assembly attaching screws.

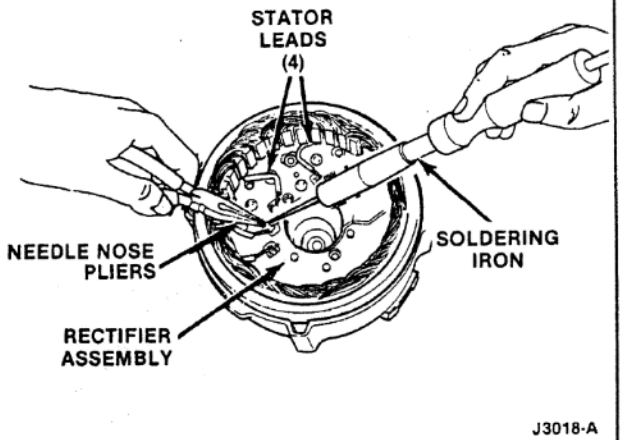


7. Position the insulator on the output terminal and install the attaching nut.



8. Position the stator in the rear housing. Route and connect the stator leads to the diodes as shown in the illustration.

   Using a 100-watt soldering iron, and rosin core solder, solder the stator leads to the diodes.

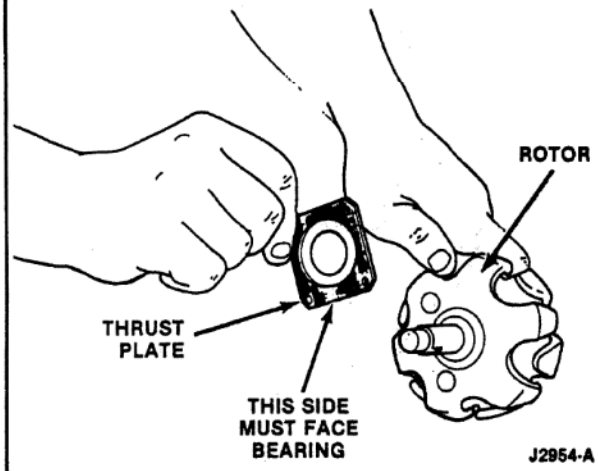


NOTE: Do not allow the soldering iron to overheat the diodes. Needle nose pliers clamped to the diode lead can be used as a heat sink to absorb heat which would otherwise damage the diodes.

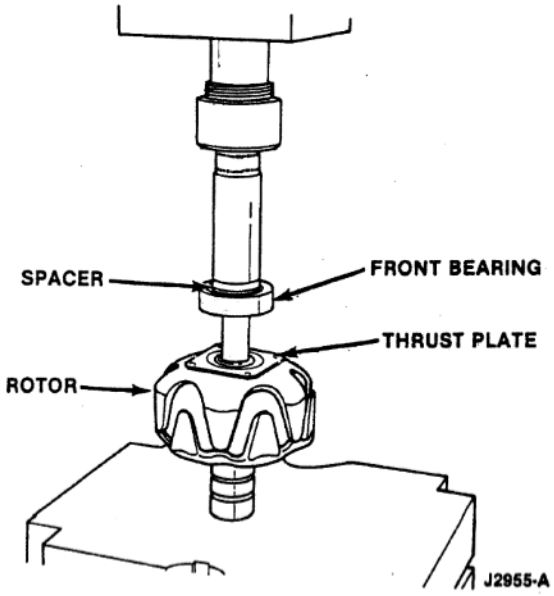
DISASSEMBLY AND ASSEMBLY

Assembly (Continued)

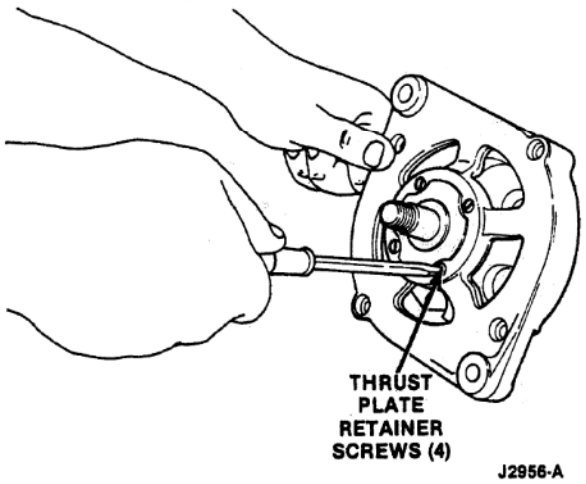
9. Install the thrust plate on the rotor.



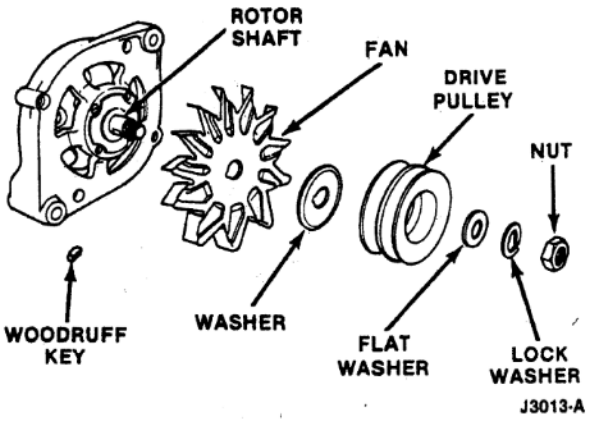
10. Install the front bearing and spacer on the rotor shaft using a suitable press.



11. Position the front housing over the rotor shaft and install the thrust plate attaching screws.



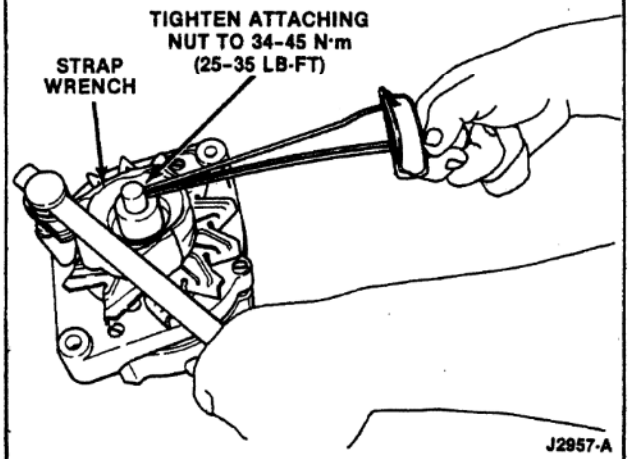
12. Install the fan, washer, woodruff key and drive pulley on the rotor shaft. Install the drive pulley attaching nut.



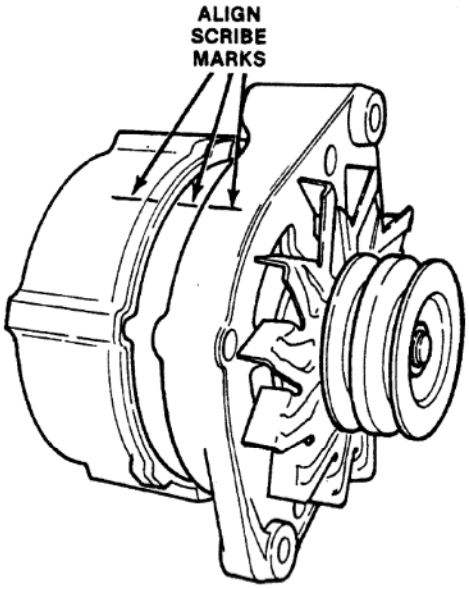
DISASSEMBLY AND ASSEMBLY

Assembly (Continued)

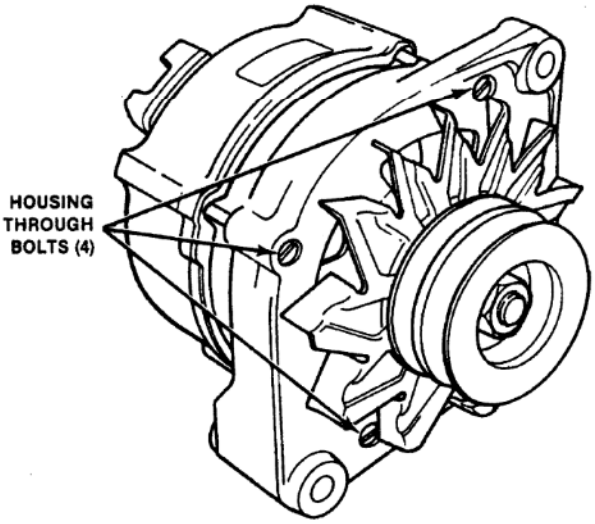
13. Tighten the attaching nut to 34 to 45 N·m (25-35 lb-ft). A strap wrench can be used to hold the pulley while the nut is tightened.



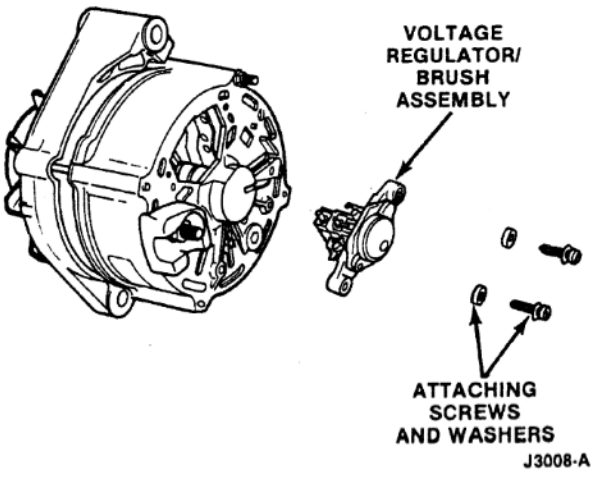
14. Position the front housing and rotor assembly on the rear housing and stator assembly using the scribe marks for alignment reference.



15. Install the four housing through bolts.



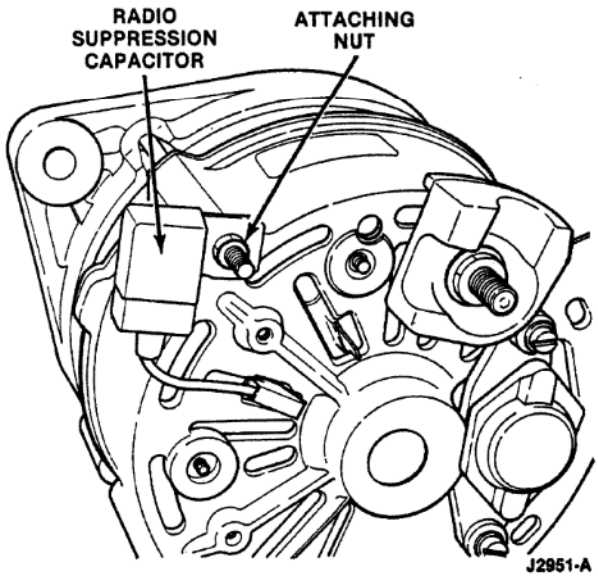
16. Install the voltage regulator/brush assembly.



DISASSEMBLY AND ASSEMBLY

Assembly (Continued)

17. Install the radio suppression capacitor.



GROUP 31 SPECIFICATIONS

BATTERY

Volts: 12
Amps of 0°F cold crank: 500
Minutes reserve capacity: 75
Amp/hour rating: 55

ALTERNATOR

Rating: 90 amp at 6000 rpm
Regulator: Electronic, integral with brush holder
Service Specifications: Minimum brush length
—5 mm (3/8 in.)
Rotor coil resistance
—3 ohms

TORQUE SPECIFICATIONS

Item	N·m	lb-ft
Adjuster pivot bolt	60-81	44-60
Adjuster nut	40-62	30-46
Pulley attaching nut	34-45	25-35

LIGHTING SYSTEM

GROUP 32 (13000)

TITLE SECTION	PAGE NO.	TITLE SECTION	PAGE NO.

HEADLAMP SYSTEM 32-02

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- Headlamps 1
- Headlamp Switch 1
- Dimmer Switch 1

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- Headlamp Aim 3

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- Headlamp Bulb Replacement 3
- Headlamp Assembly 4
- Headlamp Dimmer Switch 5

EXTERIOR LAMPS 32-20

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REMOVAL AND INSTALLATION
- Taillamp Housing Assembly 4
- Taillamp Assembly Bulbs 5
- Front Side Marker Lamps 5
- Rear Side Marker Lamps 6
- Parking Lamp Bulb 7
- License Plate Lamp Assembly 7
- Front Turn Indicator Lamp Assembly 8
- Turn Indicator Switch 9
- Fog Lamp Assembly 10
- Stop Lamp Switch 11
- High Mount Stop Lamp Bulb/ Housing Assembly 12
- Brake Lamp Relay 13

INTERIOR LAMPS 32-60

DESCRIPTION AND OPERATION
- Courtesy Lamps 1
- Map Reading Lamps 1
- Interior Lamps 1

REMOVAL AND INSTALLATION
- Interior Lamp 2
- Interior Lamp (Roof) 2
- Map Reading Lamp 3
- Vanity Mirror Bulb 3
- Load Compartment Lamp 4
- Load Compartment Lamp Switch 4
- Transmission Control Selector Lamp 5
- Courtesy Lamp Switch 5
- Glove Compartment Lamp Bulb Replacement 5

LIGHTING SYSTEM

TITLE SECTION	PAGE NO.	TITLE SECTION	PAGE NO.
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DRIVING	4		
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EXTERIOR LAMPS			

SECTION 32-02 HEADLAMP SYSTEM

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Headlamp Assembly	4
Headlamp Dimmer Switch	5

DESCRIPTION AND OPERATION

HEADLAMPS

The vehicle is equipped with halogen replaceable bulbs. The bulbs are retained by a bayonet mount retaining ring. Headlamp bulbs can be individually replaced without disturbing the headlamp alignment.

HEADLAMP SWITCH

The headlamp switch is mounted on the right-hand side of the steering column. It controls circuits to the headlamps, parking lamps, marker lamps, taillamps, license plate lamps, and instrument panel lamps.

The instrument panel lamp circuit is routed through a rheostat located on the left-hand side of the instrument panel. Light intensity is controlled by rotating the thumb wheel.

DIMMER SWITCH

The dimmer switch is mounted on the steering column. It is part of the turn/dim multiswitch assembly. A high beam indicator lamp, mounted in the cluster, glows blue when the dimmer switch is in the high beam position.

DIAGNOSIS

HEADLAMP SWITCH

NOTE: Replace burned out bulb(s) or fuses before proceeding.

CONDITION	POSSIBLE SOURCE	ACTION
Headlamps do not work. Park and tail lamps OK.	• Open or shorted wiring	• Check wiring and connections between headlamp switch and lamps. Service as necessary.
	• Poor ground connections	• Check and service as necessary.
	• Damaged dimmer switch	• Check dimmer switch, replace if necessary.
	• Damaged headlamp switch	• Check headlamp switch, replace if necessary.
All exterior lamps do not work.	• Open or shorted wiring	• Check wiring and connections between power source and headlamp switch and between headlamp switch and dash panel connector.
	• Damaged headlamp switch	• Check headlamp switch, replace if necessary.
Headlamps flash On and Off.	• Shorted circuit	• Check wiring and connections between headlamp switch and headlamps.
	• Damaged headlamp switch	• Replace headlamp switch.
All exterior lamps do not work. Headlamps OK.	• Blown fuse	• Replace fuse.
	• Open wiring or poor ground	• Check wiring and connections between headlamp switch and lamps. Service as necessary.
	• Damaged headlamp switch	• Check headlamp switch, replace if necessary.
Instrument panel lamps do not work, or will not dim.	• Blown fuse	• Replace fuse.
	• Open or shorted wiring	• Check wiring between headlamp switch and lamps.
	• Damaged headlamp switch	• Check headlamp switch, replace as necessary.

CK4751-C

ADJUSTMENTS

HEADLAMP AIM

Make headlamp aim and adjustment with Headlamp Aiming Kit Rotunda 088-00001 and Merkur Headlight Adapter Kit 088-00012. To aim the aerodynamically-styled headlamps, first replace the aimer adapters provided in Rotunda Kit 088-00001, or equivalent, with the specially designed aimer adapters included in Merkur Headlight Adapter Kit 088-00012. Use the latest instructions provided in the kit. Make the adjustment with the grille panel assembly installed.

All headlamp adjustments should be made with:

- A half tank of gasoline, plus or minus one gallon
- The vehicle unloaded and the trunk empty except for the spare tire and jacking equipment
- Recommended pressure in all tires.

The equipment in Kit 088-00012 can be calibrated to accommodate a slight slope in the floor, making it usable almost any place in the garage. However, the area must be reasonably flat.

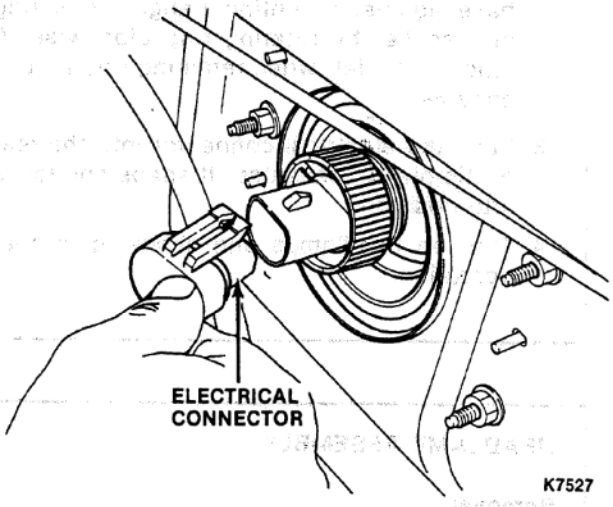
REMOVAL AND INSTALLATION

HEADLAMP BULB REPLACEMENT

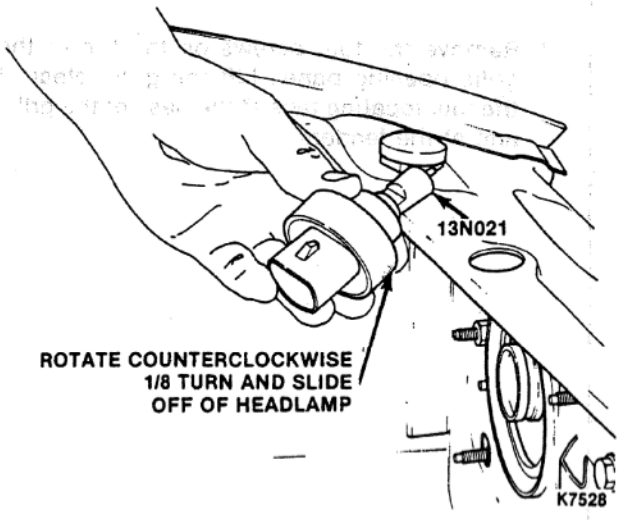
WARNING: The halogen bulb contains gas under pressure. The bulb may shatter if the glass envelope is scratched or the bulb is dropped. Handle the bulb carefully and only by its plastic base. Avoid touching the glass envelope. Keep the bulb out of the reach of children.

Removal

1. Make sure that the headlamp switch is in the "off" position.
2. Remove the electrical connector from the bulb by pulling the connector in a rearward direction.



3. Remove the bulb retaining ring by rotating it counterclockwise about one eighth of a turn and sliding it rearward off the headlamp body. Keep the ring as it will be used to retain the new bulb.



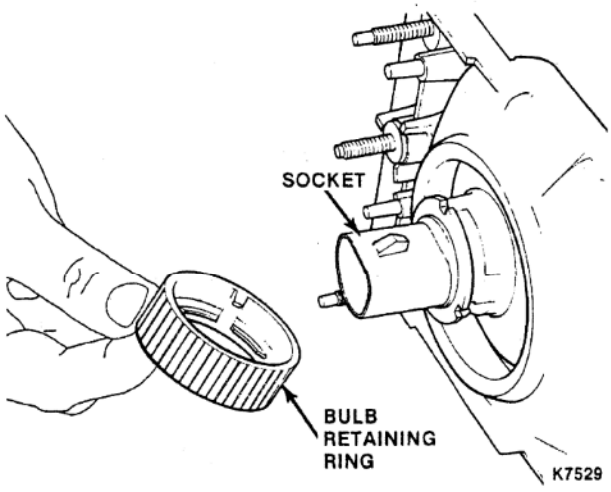
REMOVAL AND INSTALLATION (Continued)

HEADLAMP BULB REPLACEMENT (Continued)

4. Carefully remove the headlamp bulb from its socket in the reflector by gently pulling it straight out. Dispose of the burned-out bulb.

Installation

1. With flat side of plastic base of bulb facing upward, insert glass envelope of bulb into socket. Turn base left or right to align grooves in forward part of plastic base with locating tabs inside socket. When grooves are aligned, push bulb firmly into socket until mounting flange on base contacts rear face of socket.
2. Slip bulb retaining ring over rear of plastic base against mounting flange. Lock ring into socket by rotating ring clockwise. A stop will be felt when retaining ring is fully engaged.
3. Push the electrical connector into the rear of the plastic base until it snaps and locks into position.
4. Turn on headlamps and check for proper operation.



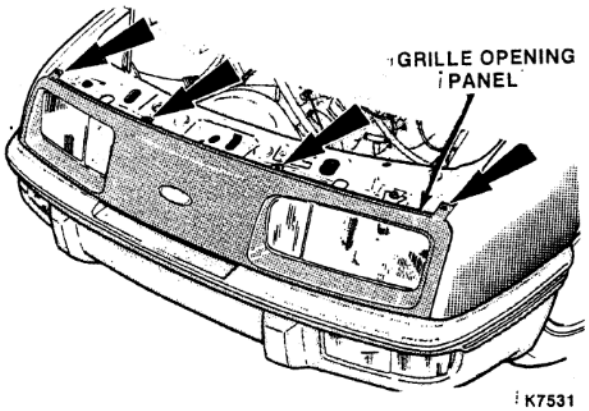
NOTE: The headlamp bulb should not be removed from the headlamp reflector until a replacement bulb is to be installed. Bulb removal for an extended period of time may allow contaminants (dust, moisture, smoke, etc.) to enter the headlamp body and affect headlamp performance.

NOTE: Reaiming the headlamp is not necessary when replacing the headlamp bulb if alignment was already correct.

HEADLAMP ASSEMBLY

Removal

1. Remove the four screws on the top of the grille opening panel. Lift the grille clear of the four locating tabs at the base of the grille and at the fenders.

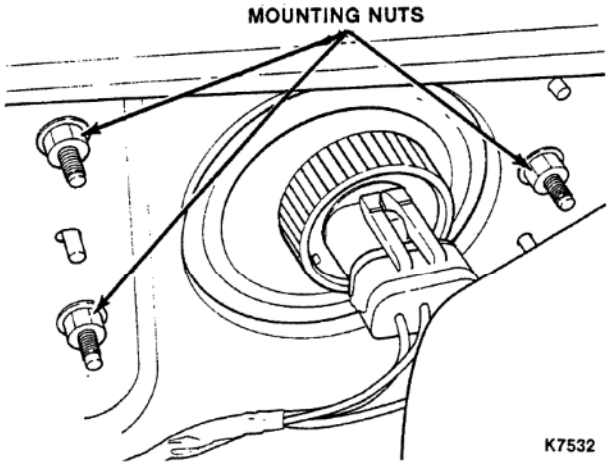


REMOVAL AND INSTALLATION (Continued)

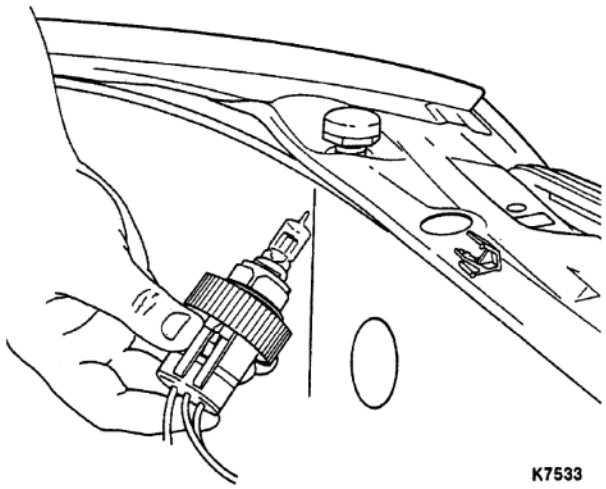
HEADLAMP ASSEMBLY (Continued)

Removal (Continued)

2. Remove the three mounting nuts securing the headlamp assembly to the body.



3. Remove the headlamp bulb assembly and wiring harness.
4. Pull the headlamp assembly from the recess.
5. Remove three retaining clips from the mounting bosses to the adjusting and mounting screws to free the headlamp from the adjusting ring.



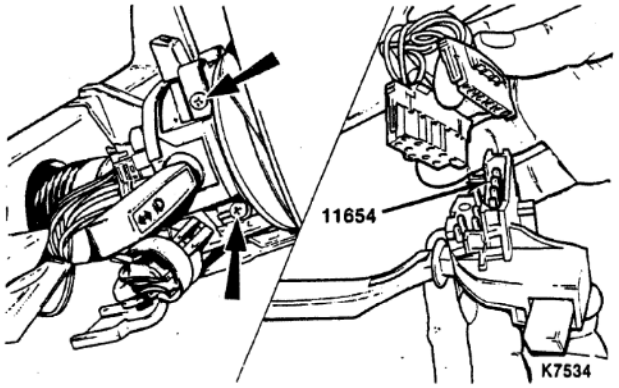
Installation

1. To install, reverse steps 1 through 5.

HEADLAMP DIMMER SWITCH

Removal

1. Disconnect the battery ground cable.
2. Remove the retaining screws; then remove the upper and lower steering column shrouds.
3. Remove the two screws securing the multi-switch assembly to the steering column; then guide the multiswitch away from the steering column.
4. Disconnect the multiconnector and ground wire connector, then remove the multiswitch.



Installation

1. To install, reverse steps 1 through 4.





SECTION 32-20 EXTERIOR LAMPS

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Rear Side Marker Lamps 6
Parking Lamp Bulb 7
License Plate Lamp Assembly 7
Front Turn Indicator Lamp Assembly 8
Turn Indicator Switch 9
Fog Lamp Assembly 10
Stop Lamp Switch 11
High Mount Stop Lamp Bulb/Housing Assembly 12
Brake Lamp Relay 13

DESCRIPTION AND OPERATION

The parking, rear and side marker lamp circuits are controlled by the headlamp switch. When the headlamp stalk is moved upwards to the first detent, the parking lamps, side marker lamps, license plate lamps, instrument panel lamps, and taillamps are activated. When the headlamp stalk is moved to the second detent, the headlamps are also activated.

The front turn indicator assemblies are dual function (park and turn signal) lamps. The front fog lamp assemblies are adjacent to the turn indicator lamps. The fog lamp rocker switch is located on the left-hand side of the instrument panel. The fog lamps will only operate when the low beam headlamps are turned on. The park/turn and fog lamp bulbs are accessible after removing the lamp assemblies from the bumper.

The taillamp assembly incorporates:

- turn indicators
- dual function tail and stop lamps
- backup lamp
- stop lamp

Access to the bulbs is from within the luggage compartment.

Side marker lamp housings are attached to the vehicle body and are visible through openings in the bumper wrap-around areas. Bulbs are accessible from underneath the vehicle.

DIAGNOSIS

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Taillamps		
One taillamp out	• Bulb burnt out	• Replace bulb.
	• Loose or corroded bulb socket	• Service or replace socket.
	• Open insulated wiring	• Check continuity of wiring.
	• Poor ground connection	• Check ground circuit.
All taillamps out	• Blown fuse in fuse panel	• Replace fuse.
	• Open insulated wiring	• Check continuity of wiring.
	• Poor ground connection	• Check ground circuit.
	• Damaged headlamps switch	• Service or replace headlamp switch.
	• Damaged relay	• Replace relay.
Backup Lamps		
Backup Lamps—one does not function	• Bulb burnt out	• Replace bulb.
	• Loose or corroded socket	• Service or replace socket.
	• Open insulated wiring	• Check continuity of wiring.
	• Poor ground connection	• Check ground circuit.
Backup Lamps—both lamps do not function	• Blow fuse (#5) in fuse panel	• Replace fuse #5.
	• Open insulated wiring	• Check continuity of wiring.
	• Poor ground connection	• Check ground circuit.
	• Backup lamp switch malfunctioning	• Service or replace backup switch
Parking Lamps		
One parking lamp doesn't light	• Bulb burnt out	• Replace bulb.
	• Loose or corroded connection at parking lamp socket	• Service or replace socket.
	• Open insulated wiring	• Check continuity of wiring.
	• Poor ground connection	• Check ground circuit.
Both parking lamps do not light	• Blown fuse in fuse panel	• Replace fuse.
	• Loose or corroded connection at parking lamp sockets	• Service or replace socket.

DIAGNOSIS

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Parking Lamps (Continued)		
	• Open in insulated wiring	• Check continuity of wiring.
	• Poor ground connection	• Check ground circuit.
	• Headlamp stalk control inoperative	• Replace control.
Side Marker Lamps		
Side marker lamps—all lamps inoperative	• Blow fuse (#18 or #19) in fuse panel	• Replace fuse #18 or #19.
	• Loose or corroded connection at side marker lamp sockets	• Service or replace socket.
	• Open insulated wiring	• Check continuity of wiring.
	• Poor ground connection	• Check ground circuit.
	• Headlamp stalk control inoperative	• Replace control.
Side marker lamps—one lamp inoperative	• Bulb burnt out	• Replace bulb.
	• Loose or corroded connection at socket	• Service socket.
	• Open in wiring	• Check continuity.
	• Poor ground	• Check ground.
Stoplamps		
Both stoplamps do not light	• Blown fuse (#7) in fuse panel	• Replace fuse #7.
	• Loose or corroded connection at stoplamp socket	• Service or replace socket.
	• Open insulated wiring	• Check continuity of wiring.
	• Poor ground connection	• Check ground circuit.
	• Stoplamp switch inoperative	• Replace switch.
Stoplamps—one lamp inoperative	• Bulb burnt out	• Replace bulb.
	• Loose or corroded connection at socket	• Service socket.
	• Open in wiring	• Check continuity.
	• Poor ground	• Check ground.
Turn Signal Lamps		
Turn Signal Lamps—one or more inoperative	• Bulb burnt out	• Replace bulb.
	• Loose or corroded connection at turn signal socket	• Service or replace socket.
	• Open insulated wiring	• Check continuity of wiring.
	• Poor ground connection	• Check ground circuit.

DIAGNOSIS

CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Turn Signal Lamps (Continued)		
Turn Signal Lamps—all lamps inoperative	• Blown fuse (#19 or #9) in fuse panel	• Replace fuse #19 or #9.
	• Open insulated wiring	• Check continuity of wiring.
	• Poor ground connection	• Check ground circuit.
	• Turn signal flasher	• Substitute a known, good flasher.
	• Turn signal switch inoperative	• Replace turn signal switch.
Hazard Flasher Lamp		
Hazard Flasher Lamps—do not flash	• Blown fuse (#9) in fuse panel	• Replace fuse #9.
	• Open insulated wiring	• Check continuity of wiring.
	• Poor ground connection	• Check ground circuit.
	• Hazard flasher inoperative	• Substitute a known, good flasher.
	• Hazard flasher switch inoperative	• Service or replace turn signal switch assembly, which includes the hazard flasher switch.
	• Relay inoperative	• Replace relay.

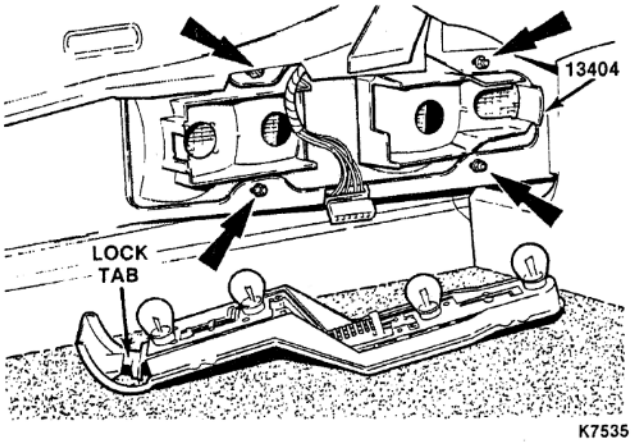
REMOVAL AND INSTALLATION

TAILLAMP HOUSING ASSEMBLY

Removal

1. Open the liftgate. Lift up the trim cover from the lower back panel.
2. Remove the bulbholder assembly from the main lamp body within the luggage compartment by depressing the lock tab on the inboard side.
3. Disconnect the multiplug connector from the bulbholder.
4. Remove the four nuts retaining the taillamp assembly and remove the assembly.

NOTE: It is not necessary to remove the taillamp assembly in order to replace a bulb.



Installation

1. Install the taillamp assembly into the vehicle and attach the four nuts. Make sure that the sealing gasket is correctly aligned.
2. Connect the multiplug connector. Make sure the wires face upward.
3. Attach the bulbholder into the taillamp assembly. Ensure lock tab snaps fully into position.
4. Lower the trim cover across the inner back panel.

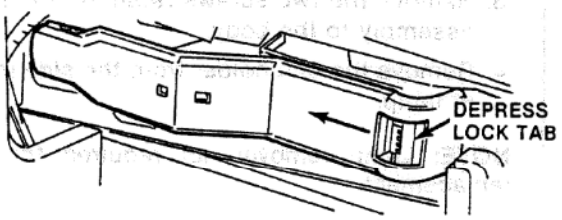
REMOVAL AND INSTALLATION

TAILLAMP ASSEMBLY BULBS

Removal

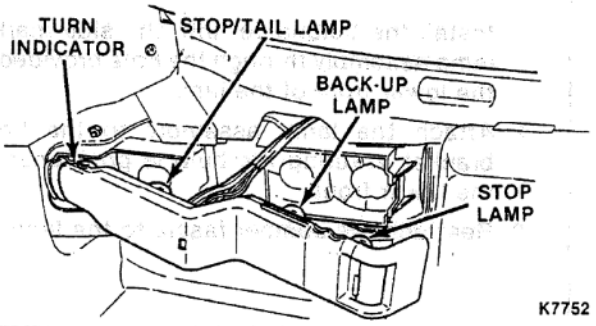
1. Open the liftgate. Lift up the trim cover from the lower back panel.
2. Remove bulbholder assembly from within luggage compartment by depressing lock tab.
3. Remove bulb to be replaced.

NOTE: Bulbs are a bayonet fit and the dual function stop/taillamp bulb is a dual filament.



Installation

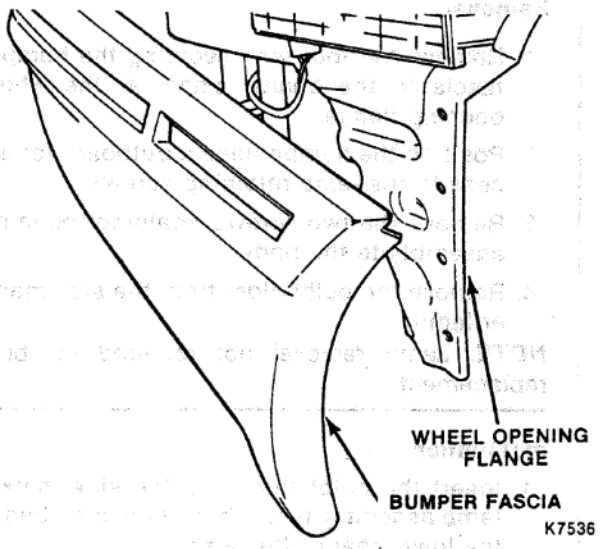
1. Fit bulb into bulbholder. Reinstall bulbholder assembly to rear of lamp and push in to ensure lock tab snaps correctly into position.
2. Test operation of bulb.



FRONT SIDE MARKER LAMPS

Removal

1. Remove the four nuts and washers securing the end of the bumper fascia to the fender at the wheel opening flange.
2. Position the bumper fascia outboard for access to the lamp retaining screws.



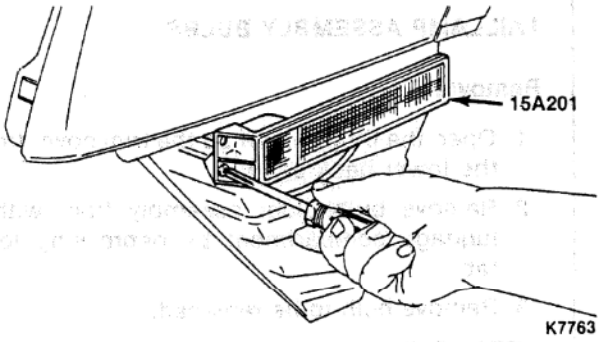
REMOVAL AND INSTALLATION

FRONT SIDE MARKER LAMPS

Removal (Continued)

3. Remove the two screws retaining the lamp assembly to the body.
4. Remove the bulbholder from the side marker lamp.

NOTE: Lamp removal not required for bulb replacement.



Installation

1. Install the bulbholder into the side marker lamp assembly through the hole provided in the lower front of the lamp.
2. Attach the lamp assembly to the body bracket assuring the bulb is positioned at the lower front.
3. Reattach the bumper fascia to the fender.

Bulb Replacement

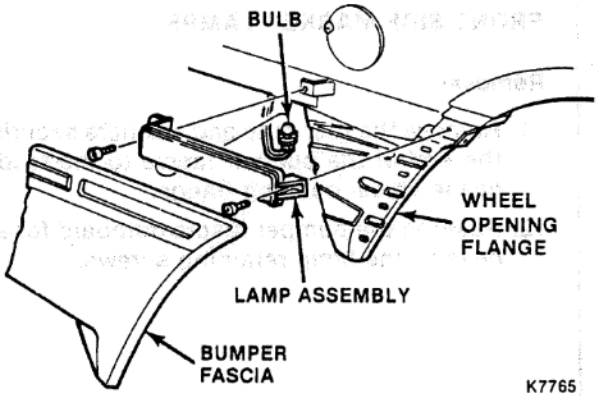
1. From underneath the vehicle, twist the lampholder counterclockwise. Pull the lampholder from the underside of the side marker lamp.
2. Replace the bulb.
3. Reinsert the bulbholder in the lamp by twisting it in a counterclockwise motion.
4. Check the operation of the lamp.

REAR SIDE MARKER LAMPS

Removal

1. Remove the four nuts securing the bumper fascia to the quarter panel at the wheel opening flange.
2. Position the bumper fascia outboard for access to the lamp retaining screws.
3. Remove the two screws retaining the lamp assembly to the body.
4. Remove the bulbholder from the side marker lamp.

NOTE: Lamp removal not required for bulb replacement.



Installation

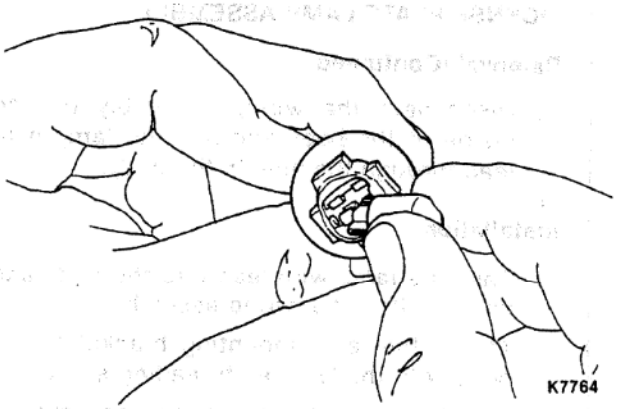
1. Insert the bulbholder into the side marker lamp assembly through the hole provided in the lower rear of the lamp.
2. Attach the lamp assembly to the body bracket with the two retaining screws assuring the bulb is properly positioned in the lower rear.
3. Reattach the bumper fascia to the quarter panel.

REMOVAL AND INSTALLATION

REAR SIDE MARKER LAMPS (Continued)

Bulb Replacement

1. With access from underneath the vehicle, twist the lampholder counterclockwise and pull from the underside of the lamp.
2. Replace the bulb.
3. Reinsert the bulbholder into the lamp by twisting it in a clockwise motion.
4. Check the operation of the lamp.



PARKING LAMP BULB

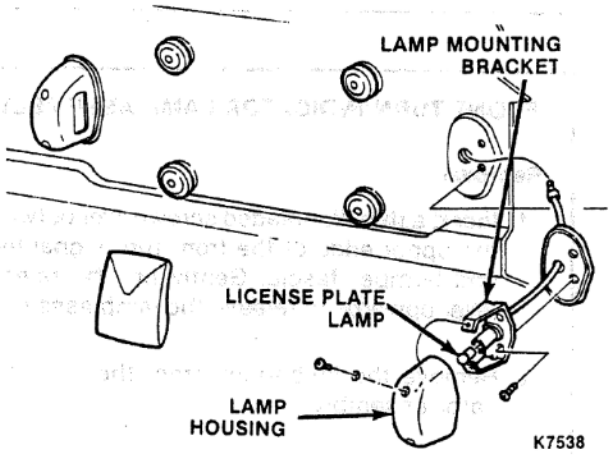
Removal and Installation

1. Parking lamps are located in the grille opening panel inboard of the headlamps. To replace the bulb, remove screws retaining grille opening panel to vehicle and remove the panel.
2. Turn bulb and remove.
3. To install, reverse steps 1 and 2.

LICENSE PLATE LAMP ASSEMBLY

Removal

1. Remove the license plate lamp housing by removing the exposed screws holding the housing to the lamp mounting bracket.
2. Remove the two self-threading screws that secure the lamp mounting bracket to the body.



REMOVAL AND INSTALLATION

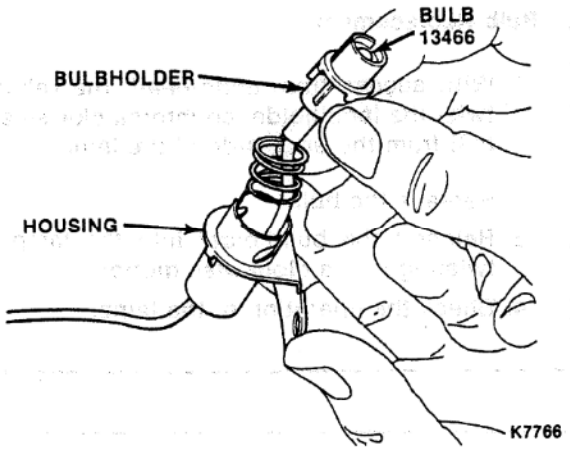
LICENSE PLATE LAMP ASSEMBLY

Removal (Continued)

3. Disconnect the wiring assembly on the inside of the body and pull the lamp wire lead through the hole in the body.

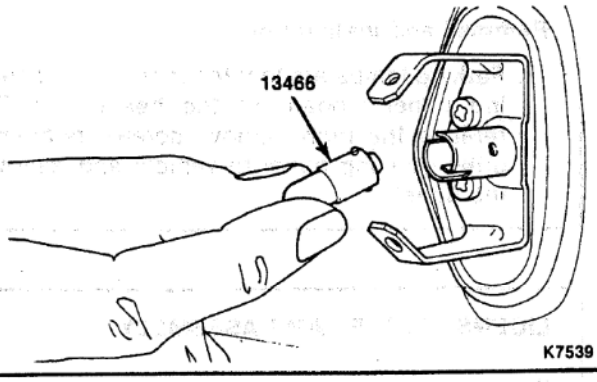
Installation

1. Pass the lamp wire lead into the body and connect it to the wiring assembly.
2. Attach the lamp mounting bracket to the body with the two self-threading screws.
3. Attach the lamp housing to the lamp mounting bracket with the two attaching screws. Make sure that the lamp-to-body seal is properly aligned.



Bulb Replacement

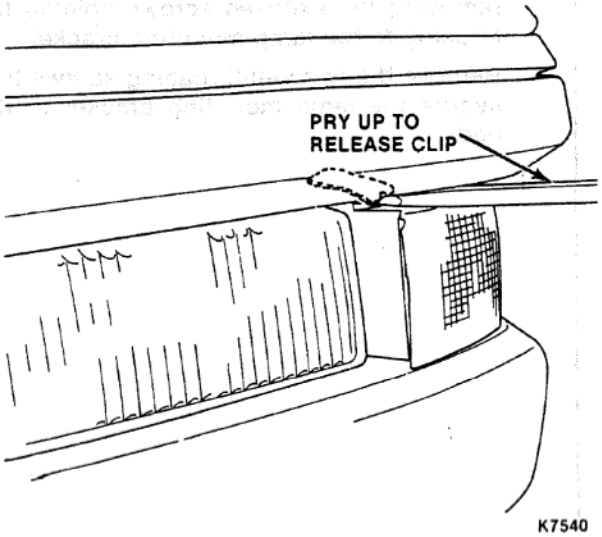
1. Remove the lamp housing from the mounting bracket by removing the exposed screw.
2. Install a new bulb.
3. Reinstall the lamp housing.
4. Check operation of the light.



FRONT TURN INDICATOR LAMP ASSEMBLY

Removal

1. Insert a thin, flat-bladed screwdriver between the upper edge of the front turn signal lens and bumper fascia. Gently pry the release lever upwards to release the lamp assembly.
2. Remove the bulbholder from the turn indicator assembly.



REMOVAL AND INSTALLATION

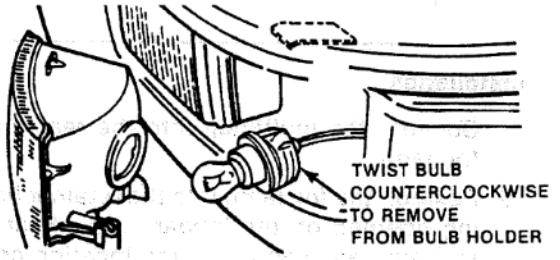
FRONT TURN INDICATOR LAMP ASSEMBLY (Continued)

Installation

1. Insert the bulbholder into the turn indicator assembly.
2. Push the turn indicator assembly into the bumper until the assembly locks into the lamp retainer housing.

Bulb Replacement

1. Remove the front turn indicator and bulbholder as outlined above.
2. Remove the bulb by twisting it counterclockwise.
3. Fit a new bulb into the bulbholder. Reinstall the bulbholder into the turn indicator assembly.
4. Mount the turn indicator assembly into the bumper recess as detailed above.

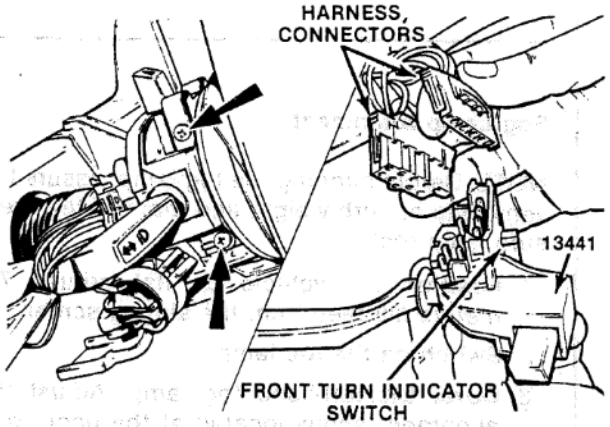


K7541

TURN INDICATOR SWITCH

Removal and Installation

1. Unscrew retaining screws and remove upper and lower steering column shrouds. Refer to Section 33-50.
2. Remove two phillips screws and guide switch assembly away from the steering column.
3. Disconnect two harness connectors from switch assembly and remove switch from vehicle.
4. To install, reverse steps 1 through 3.



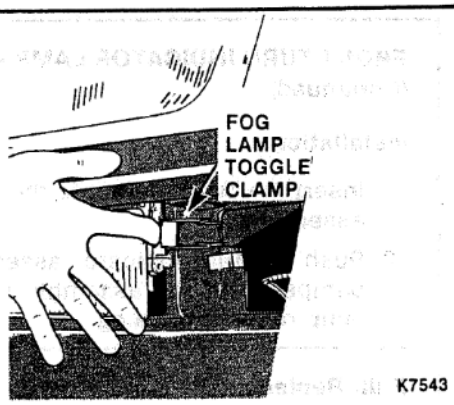
K7553

REMOVAL AND INSTALLATION (Continued)

FOG LAMP ASSEMBLY

Removal

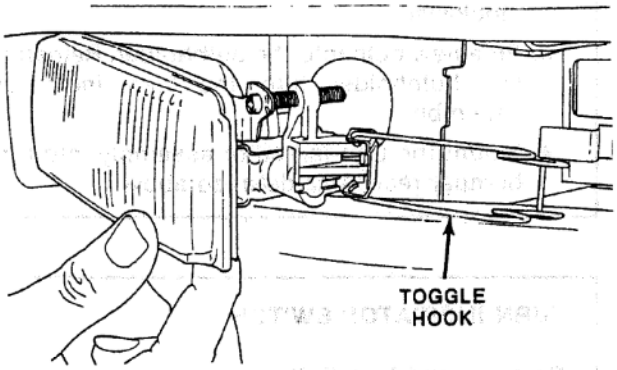
1. Remove the front turn indicator assembly as shown earlier in this section.
2. Unlatch the fog lamp toggle clamp mounted on the outboard side and pull the fog lamp assembly from the lamp retainer housing in the bumper recess.
3. Disconnect the multiplug and pull the fog lamp away from the socket location.



K7543

Installation

1. Connect the multiplug into the rear of the fog lamp.
2. Position the fog lamp into the retainer housing opening on the inboard side. Seat the fog lamp assembly into the location notch on the outboard side.
3. Engage the toggle hook around the rear of the housing and secure toggle clamp.
4. Reinstall the front turn indicator assembly. Test the operation of the fog lamp.

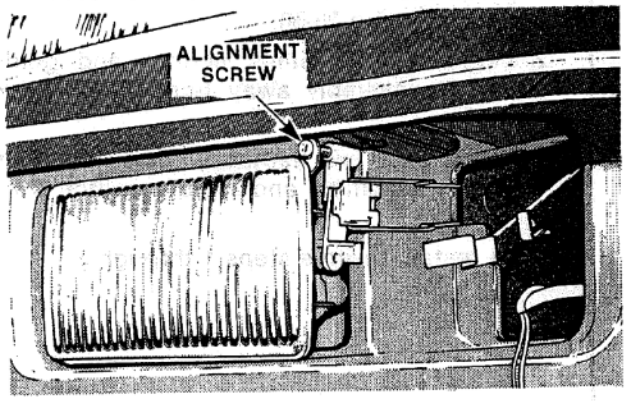


K7766

Fog Lamp Alignment

NOTE: Before aligning the fog lamp, assure the vehicle is at curb weight and that the tire pressure is correct.

1. Position the vehicle on flat ground 7.6 meters (25 feet) from the aiming screen.
2. Switch on the fog lamp.
3. Cover the left-hand fog lamp. Adjust the alignment screw located at the upper outboard corner of the right-hand fog lamp so that the top edge of the high-intensity zone on the aiming screen is 100 mm (4 in.) below the height of the lamp center (bulb focal point) on the vehicle.
4. Perform the procedure for the left-hand fog lamp by covering the right-hand fog lamp and repeating the procedure.



K7542

REMOVAL AND INSTALLATION (Continued)

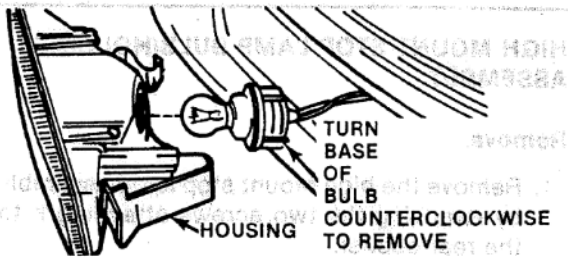
FOG LAMP ASSEMBLY (Continued)

Bulb Replacement

WARNING: The halogen bulb contains gas under pressure. The bulb may shatter if the glass envelope is scratched or the bulb is dropped. Handle the bulb carefully and only by its plastic base. Avoid touching the glass envelope. Keep the bulb out of the reach of children.

Removal

1. Be sure the fog lamp switch is in the OFF position.
2. Remove the lamp and multiplug as shown on page 32-20-10.
3. Turn base counterclockwise and withdraw from housing.



K7751

Installation

1. Install replacement bulb by grasping plastic base and inserting into housing. Base must be matched to opening in lamp when inserting. Twist bulb assembly gently but firmly clockwise to lock in place.
2. Reconnect multiplug and reinstall lamp as shown on page 32-20-10.

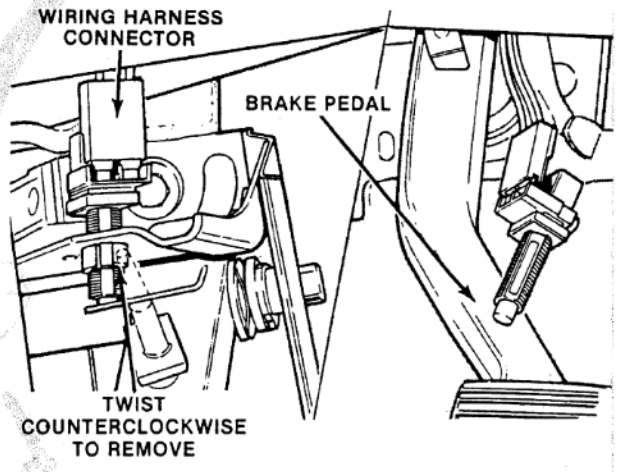
STOP LAMP SWITCH

Removal

1. Remove the lower instrument panel. Refer to Section 45-61.
2. Disconnect the wiring harness connection at the switch.
3. Twist the stop lamp switch counterclockwise and remove.

Installation

1. Insert the switch into the lock ring opening and push in until the switch barrel touches the pedal. Ensure that the pedal is not removed from its stop.
2. Twist the switch clockwise to lock. No further adjustment is required.
3. Reconnect the switch wires and check the operation of the switch.
4. Install the lower instrument panel. Refer to Section 45-61.



K7554

REMOVAL AND INSTALLATION (Continued)

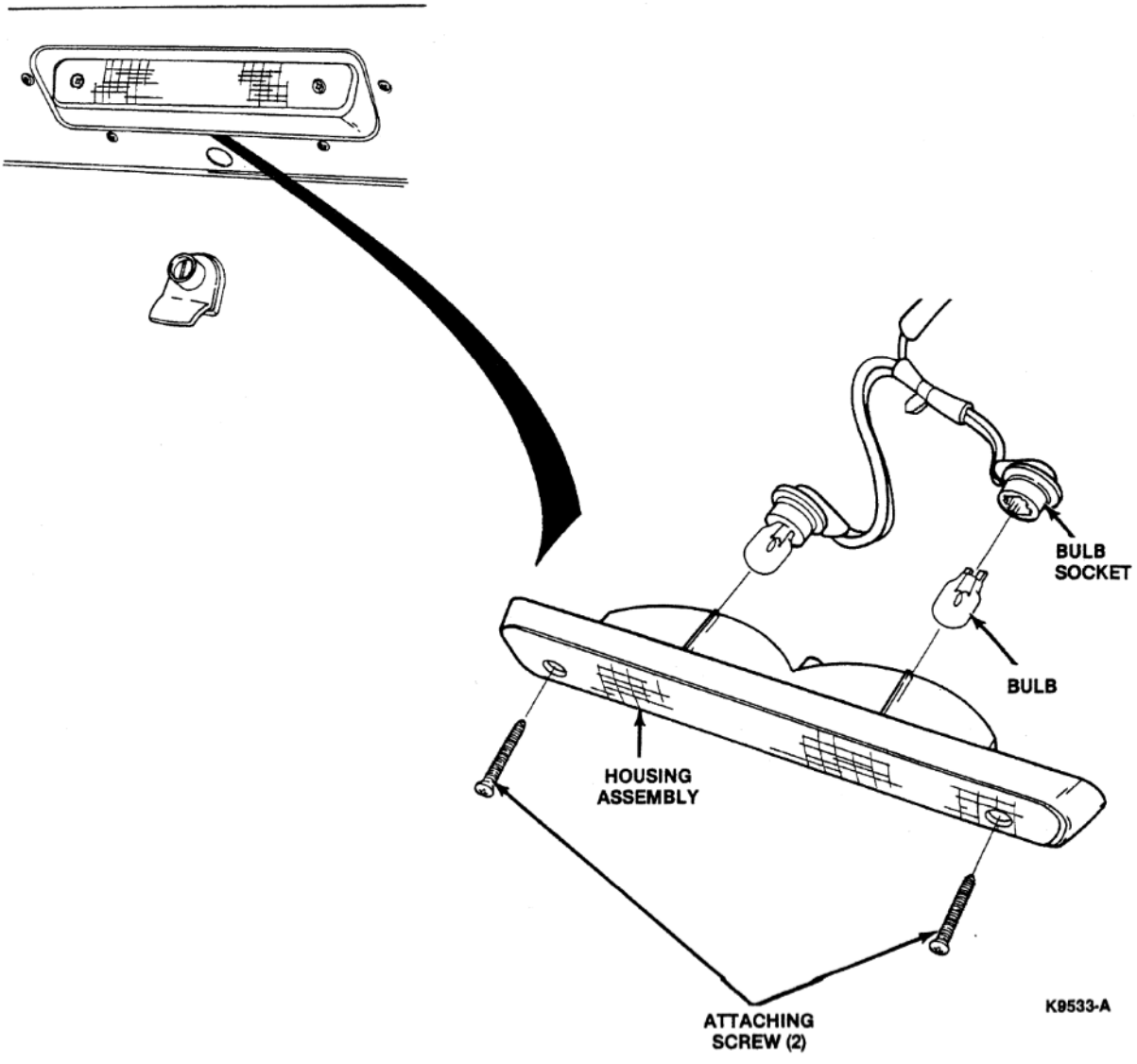
HIGH MOUNT STOP LAMP BULB/HOUSING ASSEMBLY

Removal

1. Remove the high mount stop lamp assembly by removing the two screws attaching it to the rear spoiler.
2. Pry the bulb holder with the burned out bulb out of the stop lamp housing.
3. Remove the bulb by pulling it straight out of its holder.

Installation

1. Install the bulb by pushing it straight into its holder.
2. Lubricate bulb holder with silicone and insert it into the stop lamp housing.
3. Position the stop lamp assembly in the rear spoiler and install the two attaching screws.

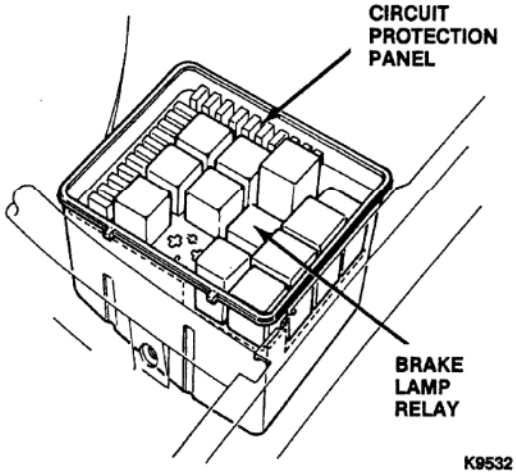


REMOVAL AND INSTALLATION (Continued)

BRAKE LAMP RELAY

Removal

The brake lamp relay is located in the circuit protection panel. The panel is located in the left rear corner of the engine compartment in the cowl well. To remove the relay, carefully grip it with needle-nose pliers and pull straight out.



SECTION 32-60 INTERIOR LAMPS

CONTENTS

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DESCRIPTION AND OPERATION

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Map Reading Lamps 1
Interior Lamps 1

REMOVAL AND INSTALLATION

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Interior Lamp (Roof) 2
Map Reading Lamp 3
Vanity Mirror Bulb 3
Load Compartment Lamp 4
Load Compartment Lamp Switch 4
Transmission Control Selector Lamp 5
Courtesy Lamp Switch 5
Glove Compartment Lamp Bulb Replacement 5

DESCRIPTION AND OPERATION

COURTESY LAMPS

The interior courtesy lamps in the roof console and front footwell floor areas are operated by courtesy switches mounted in the floor pillars and liftgate. A delayed action device allows the courtesy lamps to remain on for an additional 20 seconds after the doors have been closed. The lamps will, however, extinguish as soon as the ignition is switched on.

MAP READING LAMPS

The two map reading lamps are located in the roof console and are operated by individual rocker switches located in the interior lamp assembly.

INTERIOR LAMP

The interior lamp is located in the roof console above the windshield. It is operated by a single switch located on the lamp which has three switch positions:

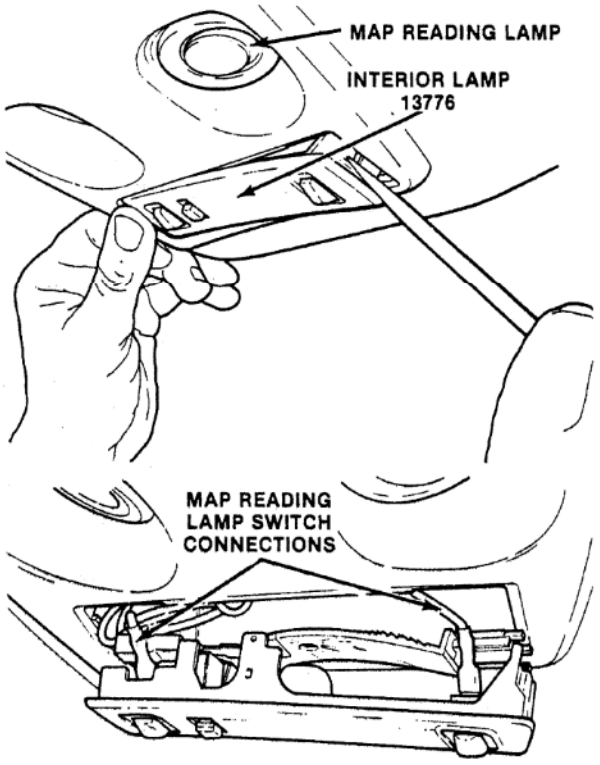
- Light on when either door is open
- Off
- Light continuously on

REMOVAL AND INSTALLATION

INTERIOR LAMP (ROOF)

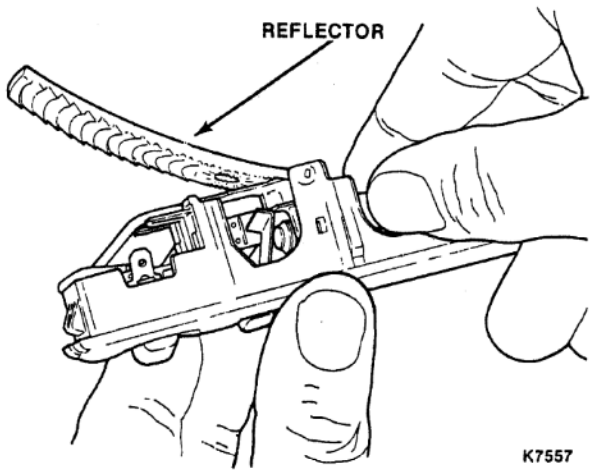
Removal

1. Ensure that the interior lamp switch is in its center "off" position.
2. Pry the interior lamp out of its aperture with a thin flat-edge screwdriver.



3. Detach the connections for the map reading lamps.

4. The reflector is a clip fit and is hinged on one side. Unclip the reflector to remove the bulb.



Installation

1. Clip the bulb into the interior lamp assembly and reconnect the wires to the lamp terminals.
2. Position the interior lamp assembly into the aperture and clip the lamp into position.

REMOVAL AND INSTALLATION (Continued)

INTERIOR LAMP (FOOTWELL)

Removal and Installation

1. Pry the interior lamp out of its aperture with a flat-edge screwdriver.
2. Remove the bulb holder from the interior lamp.
3. To install, reverse steps 1 and 2.

MAP READING LAMP

Removal

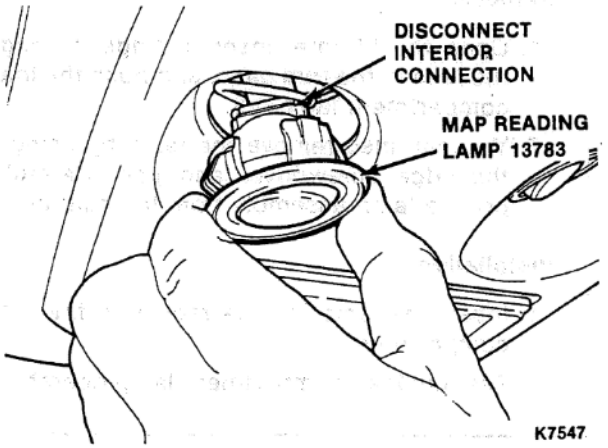
1. Carefully pry the map reading lamp out using a thin flat-edge screwdriver. With the interior lamp already removed as above, the map reading lamp can also be removed by inserting your finger into the interior lamp slot and pushing the map reading lamp outward from behind.
2. Disconnect the map reading lamp wires from the interior lamp.

Installation

1. Reconnect the lamp wires and reconnect the map reading lamp.
2. Install the interior lamp (if removed) and check the operation of both lights.

Bulb Replacement

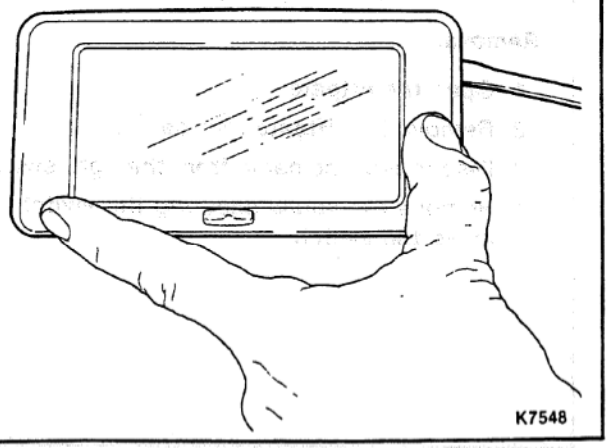
1. Remove the map reading lamp as detailed above.
2. Grasp the bulbholder and pull it out. Pull the bulb from the bulbholder. The bulbs are a wedge base.
3. Insert a new bulb into the bulbholder; insert the bulbholder into the lamp.
4. Insert the map reading lamp into the overhead console and test its operation.



VANITY MIRROR BULB

Removal

1. Lower the sun visor and pry off the mirror and reflector with a thin-edge screwdriver.

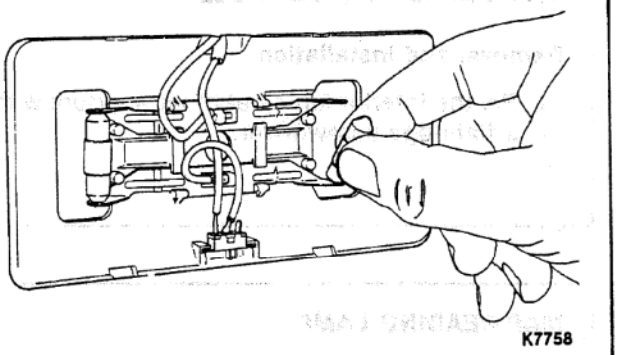


REMOVAL AND INSTALLATION (Continued)

2. Remove the bulb from the end spring contact.

Installation

1. Install a new bulb into the end spring contact.
2. Reinstall the mirror and reflector assembly.
3. Test the operation of the vanity mirror.


K7758

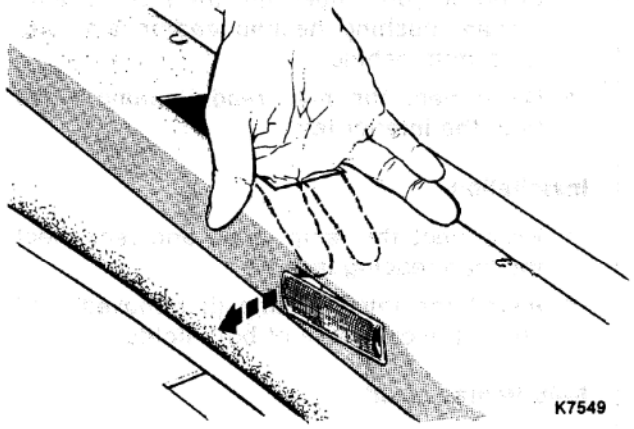
LOAD COMPARTMENT LAMP

Removal

1. Open the liftgate. Insert a finger through the hole in the trim panel and push the load compartment lamp out.
2. You can also remove the lamp by using a thin-edge screwdriver and pad. Carefully pry the lamp assembly from its location.

Installation

1. Insert the lamp into its recess in the load compartment.
2. Test the load compartment lamp operation.


K7549

LOAD COMPARTMENT LAMP SWITCH

Removal

1. Open the liftgate.
2. Remove the liftgate trim panel.
3. Disconnect the cable from the light switch.
4. Remove the screw securing the switch; remove the switch.

Installation

1. Install the switch and secure with a screw.
2. Reconnect the cable to the switch terminal and test the operation.

REMOVAL AND INSTALLATION (Continued)

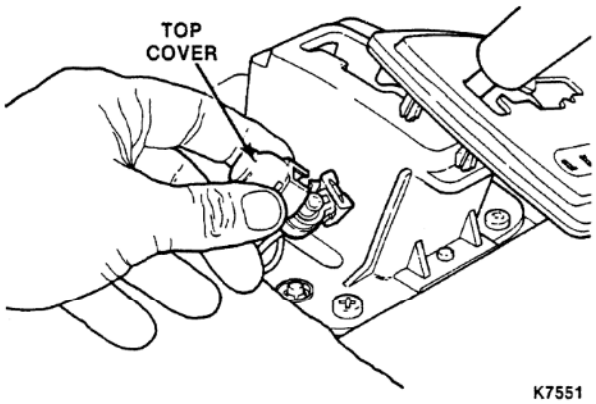
TRANSMISSION CONTROL SELECTOR LAMP

Removal

1. Remove the selector housing top cover and pull the bulbholder assembly up to detach it from the selector lever.
2. Pull the top cover off to expose the bulb. The bulb is a bayonet mount.

Installation

1. Fit the bulb in the bulbholder and push the top cover in position.
2. Clip the assembly into the selector lever and check bulb operation.
3. Install the selector housing top cover.



K7551

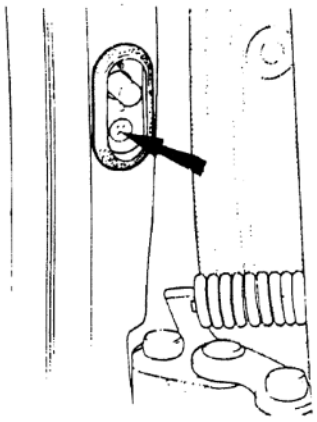
COURTESY LAMP SWITCH

Removal

1. Remove the crosshead screw securing the switch; pull out the switch.
2. Pull the switch away from the door pillar and disconnect the wiring harness.

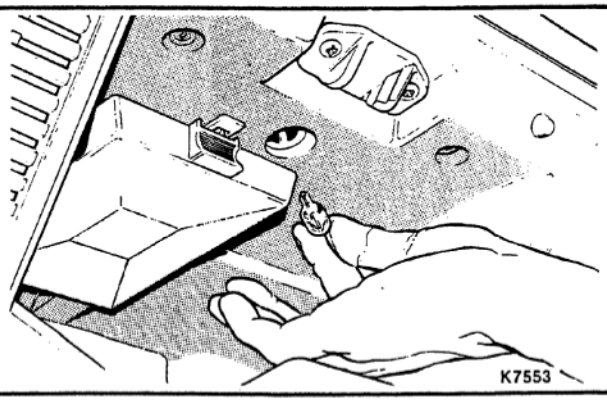
Installation

1. Reconnect the wiring harness and feed it back into the door pillar.
2. Secure the switch with the crosshead screw and check the operation of the courtesy lamp.


K7774

GLOVE COMPARTMENT LAMP BULB REPLACEMENT

1. Open the glove compartment.
2. Grasp the glass bulb and pull it out.
3. Fit a new bulb into the bulbholder and test the operation of the glove compartment lamp.


K7553

INSTRUMENTS, CLUSTERS, AND CONTROLS

GROUP 33 (10000)

TITLE SECTION — PAGE NO.

DIGITAL CLOCK 33-05

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ADJUSTMENTS
- To Set Time and Date 1
- Quick Time Set 2
- Timer Operation 2

REMOVAL AND INSTALLATION 3

FUEL INDICATING SYSTEM 33-20

DESCRIPTION
- Fuel Indicator Gauge 1
- Fuel Sender and Pump Assembly 2
- In-tank Fuel Filter 2
- Low Fuel Warning (LFW) System 2

TESTING
- Preliminary Checks 3
- Operational and Calibration Test 3
- Fuel Sender Unit In Vehicle Test 4
- Bench Test 4
- Low Fuel Warning Switch Circuit 6

REMOVAL AND INSTALLATION 7
- Fuel Sending Unit 7

INSTRUMENT CLUSTER 33-50

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- Printed Circuit 1
- Charge Indicator Lamp 2
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- Temperature Gauge System 2
- Calibration Test 2
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REMOVAL AND INSTALLATION
- Instrument Cluster Assembly 4
- Printed Circuit and Fuel/ Temperature Gauge 5
- Instrument Cluster Bulb 7
- Speedometer Head 8
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IGNITION SWITCH—LOCK BARREL 33-70

DESCRIPTION 1
TESTING
- Continuity Test 2
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REMOVAL AND INSTALLATION
- Ignition Switch Lock Barrel 3

WARNING INDICATOR, AUXILIARY WARNING INDICATOR AND GRAPHIC DISPLAY MODULE 33-92

DESCRIPTION
- Warning Indicator 3
- Auxiliary Warning Indicator 3
- Graphic Display Module 5

DIAGNOSIS
- Auxiliary Warning System Lamp Check 7
- Low Fuel, Low Coolant, and Low Windshield Washer Level Sensors 8
- Brake Pad Sensors, Oil Sensor 9
- Graphic Display Check 10
- Display Unit Test 11
- Door Circuit Test 12
- Ice Warning Circuit Test 12

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Sidemarker Lamp Circuit Test	13	Parking Brake Warning Light Switch	18
Stop Lamp Circuit Test	14	Stop Lamp Switch	18
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Fuel Sender Unit	15	Low Coolant Warning Switch	19
Low Air Temperature Sender Unit	16	Low Washer Fluid Warning Switch	20
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SECTION 33-05 DIGITAL CLOCK

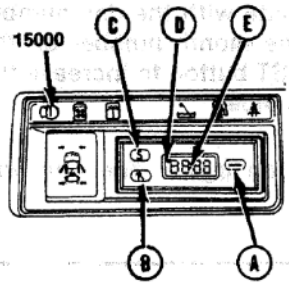
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DESCRIPTION 1

ADJUSTMENTS
- To Set Time and Date 1
- Quick Time Set 2
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REMOVAL AND INSTALLATION 3



A—SELECT BUTTON (SELECTS DISPLAY)
B—RESET BUTTON (SETS TIME SEQUENCE AND RETURNS TIMER TO ZERO)
C—ADJUST BUTTON (TIME FORMAT, TIMER STOP/ START, AND QUICK TIME SET)
D—TIMER SYMBOL
E—COLON
K7593

DESCRIPTION

The following features may be selected on the digital clock:

- Digital Clock—shows time in hours and minutes
- Date—shows the day on the left and the month on the right
- Timer—shows the elapsed time from a chosen moment in minutes and seconds or hours and minutes.

Upon switching on the ignition, the clock will show time. It has a 12-hour or 24-hour selectable format. A colon appears between the hours and minutes. When the clock is running, the colon flashes every second. The display is dimmed when the vehicle's exterior lights are switched on.

To obtain the "date" display, press the SELECT button once. After four seconds, the digital clock will reappear. To obtain the "timer" display, press the SELECT button twice. The unit will now show "00:00" with the colon static. To revert to the normal digital clock display, press the SELECT button once. Settings and adjustments can only be made with the ignition ON.

ADJUSTMENTS

TO SET TIME AND DATE

Settings must be carried out in the following sequence.

1. 12/24 Hour Format
   With the unit showing time, press the RESET button once. The display will flash showing "12H" or "24H" depending on whether the clock is set to display time in 12-hour or 24-hour format. Press ADJUST button to change display format.
2. Hours
   Press RESET button again. The hour number on the left will now flash. If the 24-hour format was selected, the minute number on the right will remain static. If the 12-hour format was selected, an "A" for a.m. or "P" for p.m. will appear in place of the minutes. Press ADJUST button to increase the flashing hour number.
3. Minutes
   Press RESET button again. The minute number on the right of the display will now flash. Press ADJUST button to increase the flashing minute number.
4. Day
   Press RESET button again. The unit will now show the day number on the left flashing with the month number on the right static. Press ADJUST button to increase the flashing month number.
5. Month
   Press RESET button again. The unit will

ADJUSTMENTS (Continued)

TO SET TIME AND DATE (Continued)

now display the date with the day number on the left and the month number on the right. Press ADJUST button to increase the flashing month number.

6. Time
   Press RESET button again. The unit will now return to the display of time.
   To revert to the display of time at any point during the setting sequence, press the SELECT button.

QUICK TIME SET

Whenever the clock reads 58, 59, 00, or 01 minutes on any hour, it can be reset to 00 minutes, 00 seconds by pressing the ADJUST button once. For minutes 58 and 59, the hour will be inclemented by one, but for minutes 00 and 01, the hour displayed will be unaffected.

TIMER OPERATION

1. To start and stop timer.

   With the clock showing time, push SELECT button twice. The clock will display "00:00" with the colon static. To start the timer, press ADJUST button once. The colon will flash and a dot—the "timer symbol" will appear on the top left of the display. Pressing the ADJUST button a second time stops the timer and freezes the display. A third press will restart the timer from where it stopped.

   The timer counts to 59 minutes and 59 seconds, then rolls over to 1 hour 00 minutes and continues to count at one-minute intervals. When it reaches 59 hours 59 minutes, it automatically resets to zero and continues to count. Either of the other two displays can be selected when the timer is in operation. To obtain the normal time display, press the SELECT button once. To obtain the date display for four seconds, press select again.

   The "timer symbol" will appear on both the time and date displays when the timer is in operation. The timer cannot be stopped or started when the clock shows the normal time display.

2. To reset timer to zero.

   With the clock showing time, press SELECT button twice to display the timer. To zero the timer, push RESET button. If the timer was running, the "timer symbol" will disappear. The clock can now be set to show the normal time display (by pressing SELECT button), or the timer can be restarted (by pressing ADJUST button).

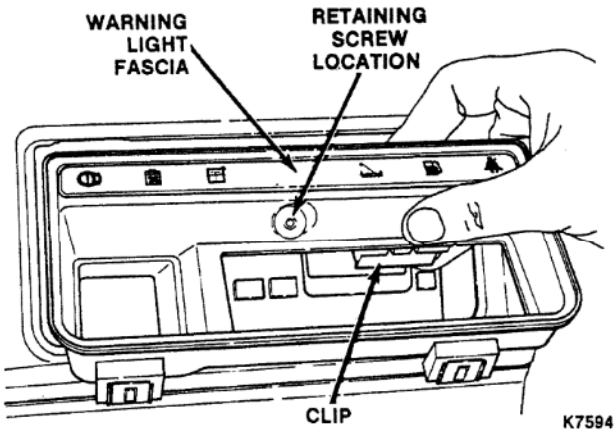
   The time recorded on the timer when the timer is stopped will be left in its memory until the timer is restarted even if the ignition is switched off. However, if the timer is running when the ignition is switched off, it will continue to record elasped time until the ignition is switched on again and the timer is stopped or reset. Thus, the timer can be used to record actual driving time or total journey time.

REMOVAL AND INSTALLATION

CLOCK

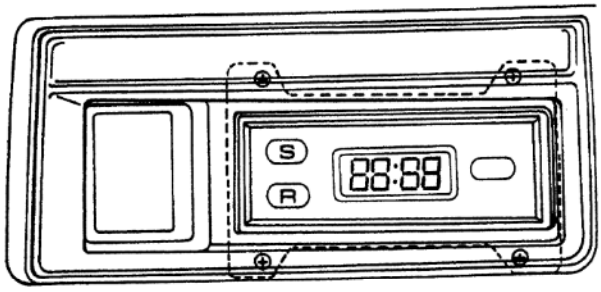
Removal

1. Disconnect the battery ground cable.
2. Remove the screw retaining the warning light fascia. Remove the fascia by pulling the bottom outward. (It is held by two spring clips at the bottom.)



K7594

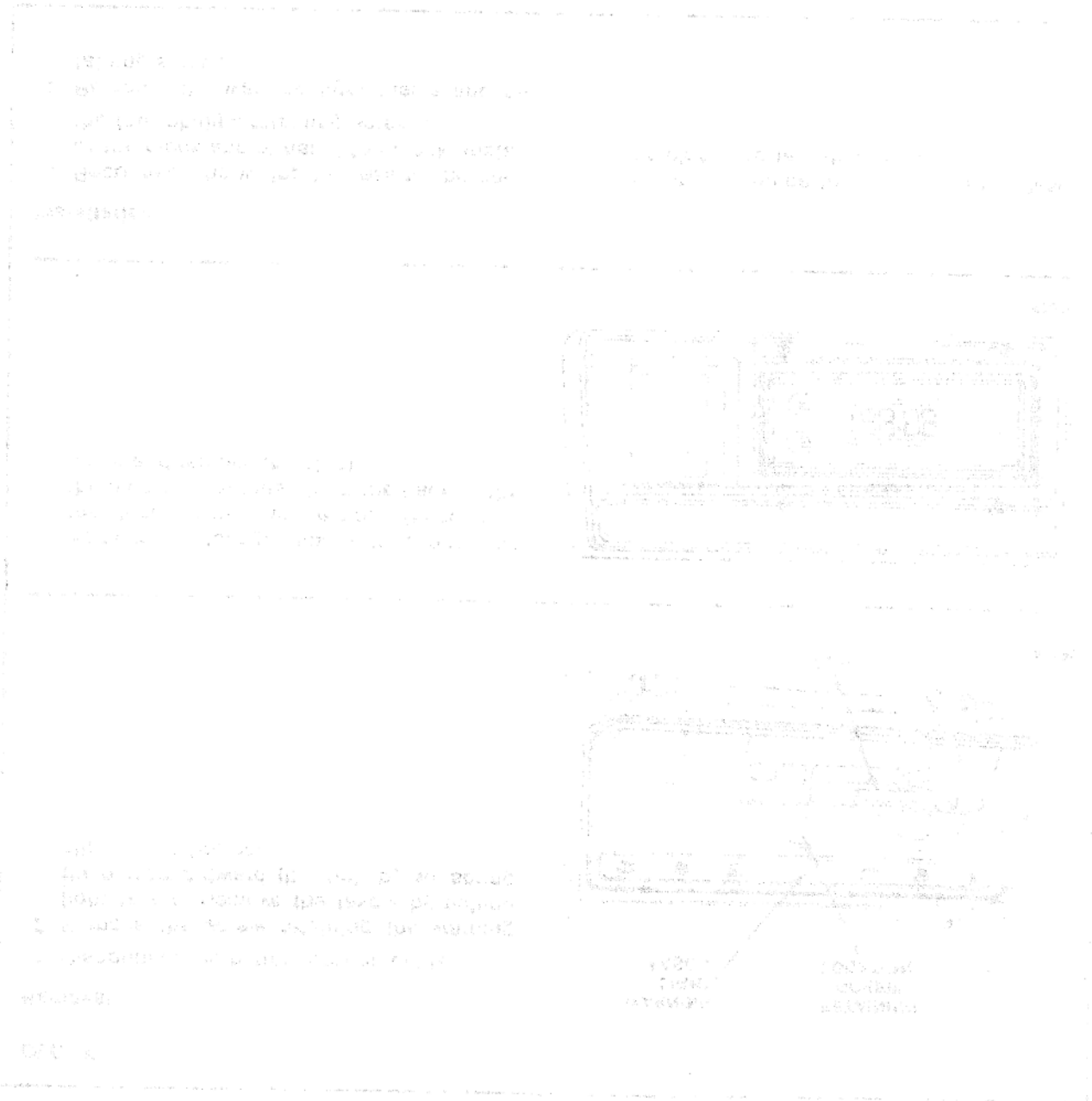
3. Remove the four phillips screws retaining the clock and pull out the clock. Disconnect the electrical harness from the back of the clock and remove the clock.



K7595

Installation

1. Reconnect the wiring harness to the back of the clock and reinstall the clock. Install the four phillips retaining screws.
2. Reinstall the warning light fascia and retaining screw.
3. Reconnect the battery ground cable. Reset the clock and test its operation.



SECTION 33-20 FUEL INDICATING SYSTEM

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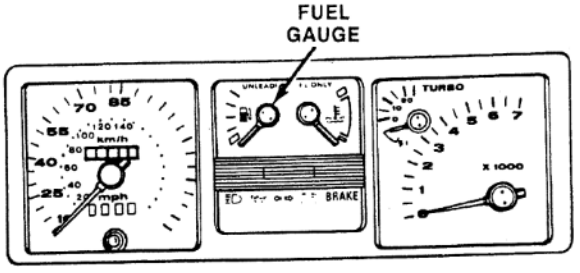
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In-Tank Fuel Filter	2
Low Fuel Warning (LFW) System	2
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Preliminary Checks	3
Operational and Calibration Test	3
Fuel Sender Unit In Vehicle Test	4
Bench Test	4
Low Fuel Warning Switch Circuit	6
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Fuel Sending Unit	7

DESCRIPTION

The fuel level indicating system is a bimetal resistance-type system consisting of a fuel gauge with integral voltage regulator (IVR) unit which is part of the fuel and temperature gauge assembly, and sender unit located in the fuel tank. The system will operate when the ignition key is in the RUN (Position "I") or ACCESSORY (Position "II") position.

FUEL INDICATOR GAUGE

The fuel indicator gauge pointer is driven by a wire wound bimetal strip, which when heated by the flow of current controlled by the fuel sender unit, produces the appropriate fuel level indication. When the current is low (low fuel level), there is little heating effect and the pointer moves a short distance. As current increases, it produces a greater heating effect, and the pointer moves a greater distance.

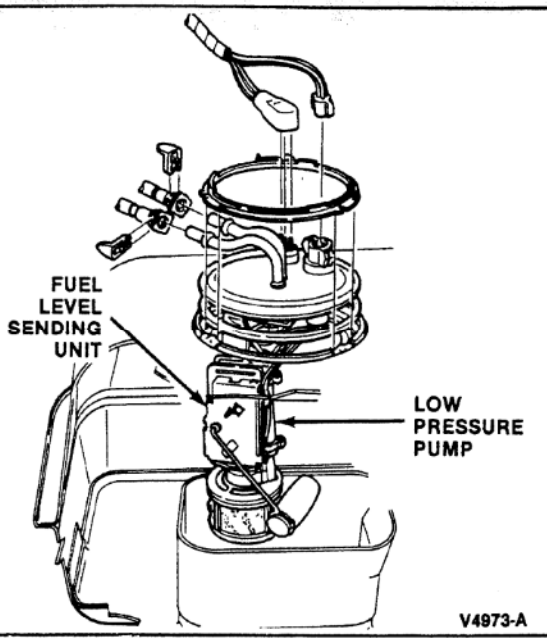


K7742

DESCRIPTION (Continued)

FUEL SENDER AND PUMP ASSEMBLY

The fuel sender has an electric pump as part of the assembly. Refer to Section 24-35 for electric fuel pump service and diagnosis.

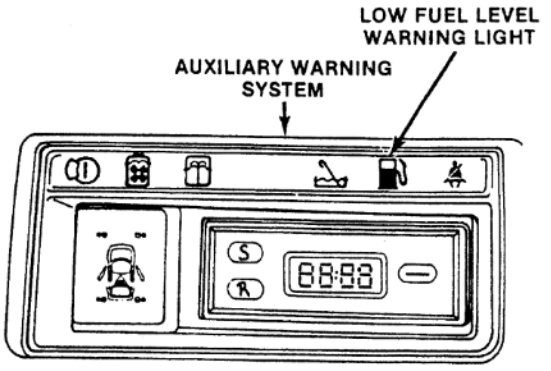


IN-TANK FUEL FILTER

The filter on the fuel sender is replaceable should it become clogged. Cleaning is not recommended. It must be hand pressed onto the bottom of the electric pump.

LOW FUEL WARNING SYSTEM

The low fuel warning switch is an electronic sensing device and is part of the fuel gauge float unit located in the fuel tank. The low fuel indicator lamp will glow when the fuel tank contains less than 5.4 liters (1.4 gallons). It is not adjustable and is field serviced only by replacement. The system has a prove-out feature to check lamp operation each time the ignition switch is turned ON.



NOTE: Diagnostic, removal and installation procedures for the fuel indicator gauge are located in Section 33-50, Instrument Cluster.

NOTE: Additional auxiliary warning diagnostic and removal/installation procedures are located in Section 33-92 Auxiliary Warning Indicator.

DESCRIPTION (Continued)

SPECIAL SERVICE TOOLS REQUIRED:

Connector Release	T82L-9500-AH
Gasoline Tanker	Rotunda 034-00002
Digital Voltohmmeter	Rotunda 007-00001
Components Analyzer	Rotunda 059-00003

TESTING

PRELIMINARY CHECKS

1. Visually inspect fuel tank for damage. A fuel tank that is collapsed or distorted from its normal shape will seriously affect the fuel indicating system.
2. Occasionally, the fuel tank may not fill completely. This will result in the fuel gauge not reaching the "FULL" mark. Check the fuel gauge by shaking the vehicle after the first fuel blow back or pump nozzle cutoff. Then, slowly meter fuel into the tank with the shut-off nozzle just inside the restrictor door. If the fuel gauge reaches full after this procedure, the fuel indication system is operating satisfactorily.

NOTE: The integral voltage regulator (IVR) also supplies a common regulated voltage for the fuel and temperature gauges. If both fuel and temperature gauges exhibit similar problems (fluctuating intermittently or a high or low reading), the IVR is damaged and the fuel and temperature gauge assembly must be replaced.

OPERATIONAL AND CALIBRATION TEST

CAUTION: Do not ground or spark either terminals or leads of the integral voltage regulator. It will cause damage to the IVR or instrument cluster printed circuit assembly.

1. Disconnect wiring connector from the terminals at the fuel sender. Clean corrosion or foreign material from terminals if necessary. Connect a voltmeter between the gauge lead (blue/black) in the connector that was disconnected from the fuel sender, and a suitable ground, other than the ground wire in the chassis-side wiring harness.
2. With the ignition switch in the ON position, look for 10 volts on the meter. If present, go to step 6; if not, go to step 3.
3. At the instrument cluster, connect the voltmeter between the fuel gauge terminal (yellow) and ground. Look for 10 volts; if present, inspect and repair the wiring as necessary.
4. Recheck for 10 volts. If 10 volts is still not present, go to step 5.
5. Connect voltmeter leads between the red gauge lead and ground. If 10 volts is observed at this point, replace the amplifier assembly. If not seen, replace the fuel gauge and repeat steps 1 and 2.
6. Move the ground lead of the meter to the ground lead (brown) in the fuel pump connector. With the ignition switch in the ON position, look for 10 volts. If present, go to step 7; if not, trace and service the ground wire and connections. Repeat step 6.
7. Obtain a pair of test resistors: 18 ohms (plus or minus 5%) at 10 watts or more and 275 ohms (plus or minus 10%) at 1 watt or more and proceed to step 8. If you have an XR4TI fuel sender of known quality, go to step 9.

TESTING (Continued)

OPERATIONAL AND CALIBRATION TEST (Continued)

8. Disconnect wiring connector at the fuel gauge sender. Connect resistors one at a time between gauge lead and ground lead of wiring connector. With the ignition switch ON and 18 ohm resistor connected, the fuel gauge should read FULL or above, and with 275 ohm resistor connected, the fuel gauge should read EMPTY or below. If the fuel gauge performs correctly, proceed to the fuel sender unit test; if not, go to step 8.
9. Disconnect the wiring connector from the sender and connect to the known quality fuel sender (of known quality). With the ignition switch ON, and float rod against the full stop (away from the filter), the fuel gauge should read FULL or above. With the float rod against the empty stops, the fuel gauge should read EMPTY or below. Allow two minutes for stabilization at each sender stop.
10. If the gauge did not read correctly at EMPTY or FULL, replace the fuel/temperature gauge assembly and repeat step 6 or 7. If the gauge reads correctly, proceed to step 9.
11. If the fuel gauge systems continues to read high or low or fluctuate, proceed to test the fuel sender unit.

FUEL SENDER UNIT

In Vehicle Test

1. Inspect fuel tank for distortion or damage.

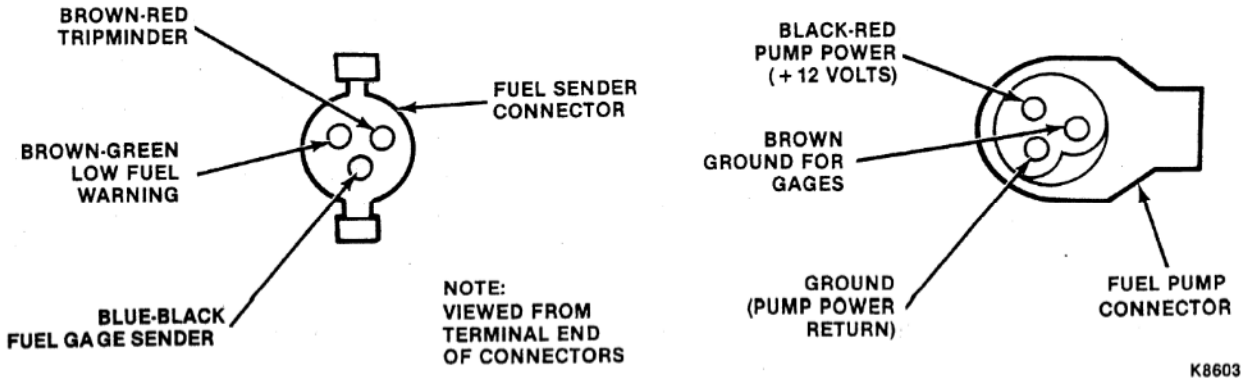
NOTE: If fuel tank is damaged or distorted, replace before further testing.

2. Connect one lead of the Rotunda Digital Volt/Ohmmeter 007-00001, or equivalent, to the ground terminal (brown) in the fuel pump connector, and the other lead to the fuel gauge sender terminal (blue/black).
   a. If the ohmmeter reads between 18 and 255 ohms, proceed to step 3.

CAUTION: Be careful to be on the fuel gauge terminal rather than the trip computer or low fuel warning terminal.

   b. If the ohmmeter reads below 18 or above 255 ohms, replace the fuel sender unit.

WIRE ASSEMBLY CONNECTORS TO FUEL PUMP/SENDER UNIT



SUPPLEMENT 1

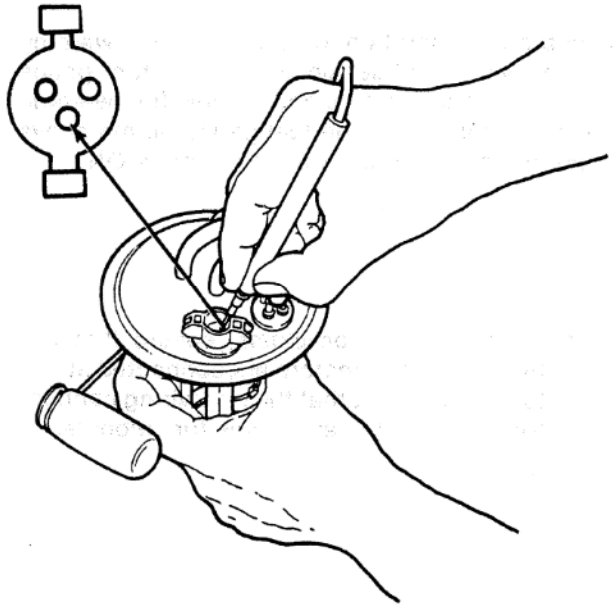
TESTING (Continued)

FUEL SENDER UNIT (Continued)

3. Fill the fuel tank to capacity. The ohmmeter readings should be between 18 and 20 ohms resistance.
   a. If the ohmmeter reads between 18 and 20 ohms, proceed to step 4.
   b. If the ohmmeter reads below 18 ohms or above 20 ohms resistance, replace the fuel sender unit.
4. Use Rotunda Gasoline Tanker 034-00002, or equivalent, to drain all the fuel from the fuel tank. Observe the ohmmeter reading while the fuel tank is being drained.
   a. If the resistance increases smoothly without jumping or hesitating, proceed to step 5.
   b. If the resistance jumps or hesitates, replace the fuel sender unit.
5. When the fuel tank is empty, the ohmmeter reading should be between 245 and 255 ohms resistance. If not, replace the fuel sender unit.

Bench Test (with Sender Removed from Fuel Tank)

1. Connect one lead of an ohmmeter to the ground terminal of the fuel sender connector and the other lead to the variable resistor terminal. Position the float rod against the EMPTY stop (closest to the fuel filter).
   a. If the ohmmeter reads between 245 and 255 ohms, proceed to step 2.
   b. If the ohmmeter reads less than 245 ohms, or above 255 ohms, replace the fuel sender unit.



K7748

2. Observe the ohmmeter reading while slowly moving the float between the EMPTY and FULL float rod stops.
   a. If the resistance increases or decreases smoothly without jumps or hesitation, and the ohmmeter reading throughout the arm swing is between 18 and 255 ohms, proceed to step 3.
   b. Throughout the arm swing, if the ohmmeter reads above 255 ohms or below 18 ohms, replace the fuel sender.
   c. If the resistance reading jumps or hesitates while smoothly moving the float rod, replace the fuel sender unit.
3. Move the float rod to FULL stop position (furthest away from fuel filter). The ohmmeter should read between 18 and 20 ohms resistance. If the ohmmeter reads outside of these values, replace the fuel sender unit.

TESTING (Continued)

FUEL SENDER UNIT BENCH TEST (with Sender Removed from Fuel Tank) (Continued)

4. Before reinstalling or installing a new fuel sender unit, the wire harness connector should be connected to the fuel sender unit and the float rod moved away from the EMPTY to FULL stops to check the fuel gauge readings.

NOTE: Check the float before reinstalling a fuel sender unit in the fuel tank. Be sure that the float is not:

- Filled with fuel
- Badly distorted
- Loose on float rod.

Check the fuel sender locating tabs. Be sure the tabs are not bent allowing the sender unit to rotate on the gasket surface as the locking ring is installed.

LOW FUEL WARNING SWITCH CIRCUIT

Improper operation of the low fuel warning lamp will be observed only if the fuel gauge points to the red area and the low fuel warning lamp is OFF, or if the fuel gauge points above the red area and the warning lamp is ON.

1. If either condition exists, ensure that the two wiring connectors are connected at the fuel sender, and that the one wiring connector is connected at the low fuel module.
2. If connections are OK, proceed to step 3.
3. Disconnect the wire assembly to the low fuel warning switch. With the ignition ON, test the connector terminal with the brown-green wire, circuit number 31B-55, with a voltmeter. If 12 volts (battery voltage) is measured, proceed to step 4; if 12 volts is not measured, check the low fuel warning lamp bulb and the interconnecting wire assemblies and repair as necessary. Then, repeat step 3.
4. With the ignition switch ON, connect a pair of resistors (both ½ watt, 180 ohms +5% and 1200 ohms +5 %) one at a time between the connector terminal (circuit 31B-55) and ground. If the low fuel warning lamp is ON with 180 ohms and OFF with 1200 ohms but the low fuel warning lamp continues to display incorrect operations, replace the fuel gauge sender and pump assembly.

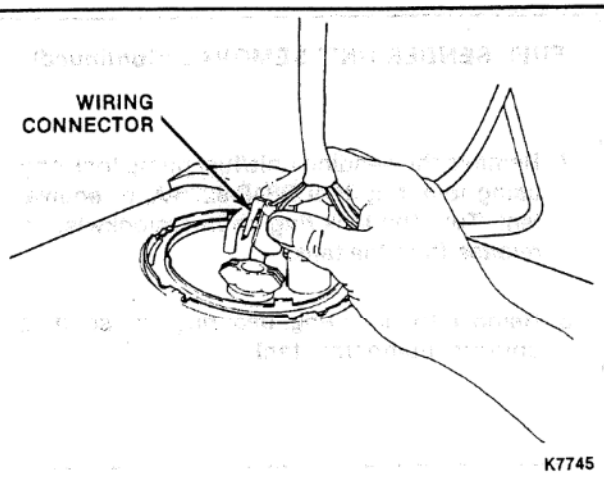
REMOVAL AND INSTALLATION

FUEL SENDER UNIT

Removal

CAUTION: Fuel supply lines will remain pressurized for some period of time after the engine is shut OFF. This pressure must be relieved before servicing of the fuel system is begun. Refer to Section 24-50 for Fuel System Pressure Relief procedure.

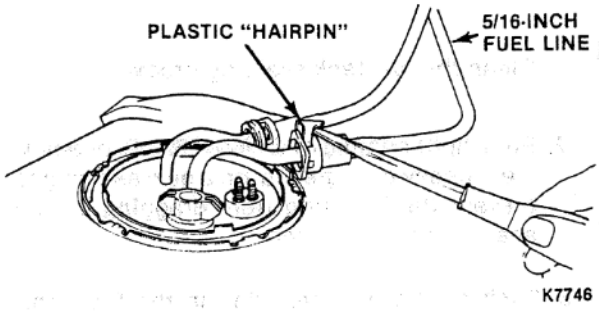
1. Drain the fuel tank and remove the fuel tank.
2. Remove any dirt that has accumulated around the sending unit so that it will not enter the tank or connections.
3. Disconnect wiring connector from fuel sensor.



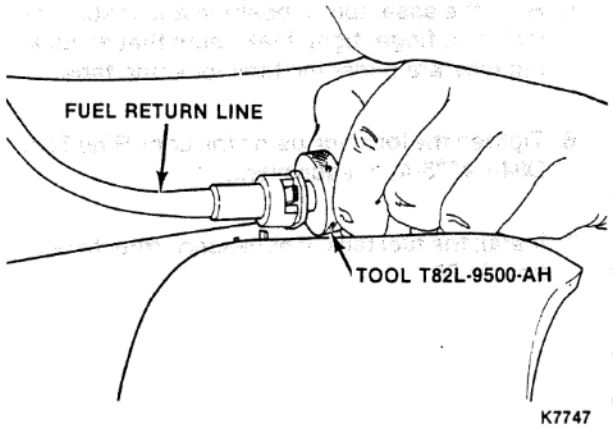
4. Remove "hairpin" type clip from fitting by first bending the shipping tab downward so that it will clear the body. Next, (using hands only) spread the two clip legs about 3.2 mm (1/8 in.) each to disengage the body and push the legs into the fitting. Complete removal is accomplished by lightly pulling from the triangular end of the clip and working it clear of the tube and fitting.

CAUTION: Do not use any tools.

5. Grasp the fitting and hose and pull in an axial direction to remove the fuel line from the steel tube.



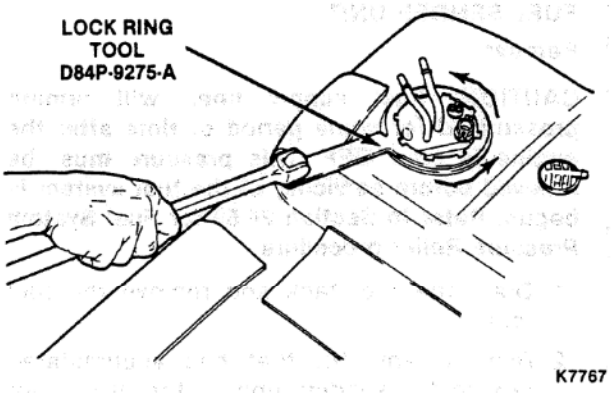
6. To remove the 1/4-inch fuel return line, slide Tool T82L-9500-AH, or equivalent, on the steel tube with small end of tool toward connector. Press tool into connector to release. If connector does not release, rotate tool 1/4 turn and repeat.



REMOVAL AND INSTALLATION (Continued)

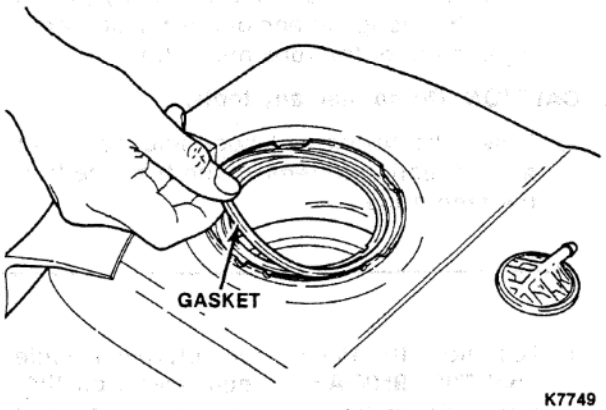
FUEL SENDER UNIT REMOVAL (Continued)

7. Remove the sending unit/fuel pump lock ring using lock ring tool D84P-9275-A, or equivalent. Turn the lock ring counterclockwise to release from the tank.
8. Remove the lock ring, seal ring and sending unit/fuel pump from tank.



Installation

1. Clean the fuel tank seal ring groove.
2. Put a light coating of C1AZ-19590-B, or equivalent heavy-duty grease, on a new seal ring to prevent the lock ring from dragging on the seal during installation.
3. Position the new seal ring in the fuel tank groove.
4. Position the sending unit/fuel pump in the fuel tank.
5. Hold the assembly in position and install the lock ring finger tight. Make sure that all locking tabs are under the tank lock ring tabs.
6. Tighten the lock ring using the Lock Ring Tool D84P-9275-A, or equivalent.
7. Install the fuel tank. If necessary, refer to Section 24-50.



SECTION 33-50 Instrument Cluster

SUBJECT	PAGE
DESCRIPTION	33-50-1
REMOVAL AND INSTALLATION	
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Instrument Cluster Bulb	33-50-6
Printed Circuit and Fuel/Temperature Gauge	33-50-4
Speedometer Cable	33-50-7
Speedometer Head	33-50-6
Tachometer/Turbo Boost Gauge Assembly	33-50-8

SUBJECT	PAGE
TESTING	
Calibration Test—Temperature Gauge	33-50-2
Charge Indicator Lamp	33-50-1
Oil Pressure Indicator	33-50-2
Printed Circuit	33-50-1
Speedometer/Odometer	33-50-3
Temperature Gauge System	33-50-2

DESCRIPTION

The instrument cluster includes the speedometer, tachometer, fuel and temperature gauges, and the turbo boost/vacuum gauge (mounted with the tachometer). The gauges and pointers are backlighted when the headlamps are switched on. The five warning lights give visual warning of direction indicators, low brake fluid level/parking brake ON, headlamp high beam, low alternator output and low oil pressure.

The turbo boost/vacuum gauge indicates positive pressure (boost) during turbocharged operation and negative pressure (vacuum) when the engine is not in a boost mode. The gauge is marked from - 15 psi to 20 psi and is connected to the intake manifold by means of a vacuum line.

TESTING

Printed Circuit

The printed circuit, which supplies current to the instrument cluster lamps and gauges, is made of copper foil bonded to a mylar base. The printed circuit is mounted to the cluster backplate. Due to its location, it cannot be easily inspected and/or tested in the vehicle. This makes the printed circuit vulnerable to damage when a probe is used for in-vehicle testing. The probe can pierce the printed circuit or in some cases burn the copper conductor. Since there is no approved procedure for in-vehicle testing of the printed circuit, it must be removed for visual inspection. If no visual damage is evident, each circuit should be tested with an ohmmeter or test lamp. If an open or short circuit is detected, the printed circuit must be replaced.

Charge Indicator Lamp

To test the charge indicator lamp, turn the ignition switch to the RUN position with the engine OFF. The lamp should come on. If it does not, disconnect the harness connector from the "D" terminal at the alternator and ground the wiring terminal on the alternator housing. Turn the ignition switch to the RUN position. The charge indicator lamp should come on. If it does not, check the bulb, wiring and cluster printed circuit. If no problem is found, replace the voltage regulator. If necessary, refer to Section 31-12.

When starting in cold ambient temperatures (when the engine is cold), the charge indicator lamp may stay on. While the lamp is on, the charging system is not functioning. Increasing the engine speed above 2000 RPM energizes the alternator, which makes the lamp go off.

The cause for this is low voltage passing through the warning lamp to the alternator. This low voltage cannot provide initial excitation for energizing the alternator field at start-up.

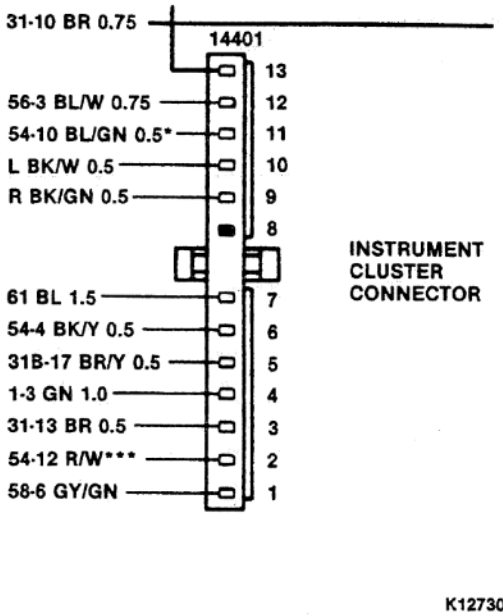
This can be corrected by installing a 100 ohm-10 watt resistor in parallel with the warning lamp. These resisters can be obtained from a local source.

1. Remove the instrument cluster. If necessary, refer to the procedure in this Section.
2. Locate the blue wire at pin 7 and the black with yellow tracer wire at pin 6 in the multi-plug connector for the cluster as shown.
3. Splice the resistor leads into these two wires using suitable connectors or solder joints. Tape the splices.

TESTING (Continued)

NOTE: The resister must be positioned and secured to the wire harness so that it does not rattle or contact any components. Do not tape over the porcelain body of the resister. It must be exposed to dissipate heat.

4. Install the cluster. If necessary, refer to the procedure in this Section.



Oil Pressure Indicator

Disconnect the temperature switch wire before testing the oil pressure indicating system on those vehicles that have an engine warning lamp.

To test the oil pressure switch and indicator lamp, turn the ignition switch on, but do not start the engine. The indicator lamp should come on.

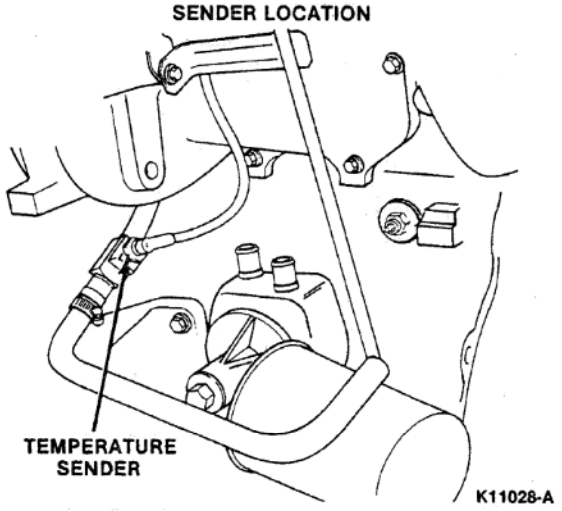
- If the indicator lamp does not come on, remove the wire from the switch terminal and connect the wire to ground. If the lamp now comes on, the oil pressure switch is in operative. Replace the switch.
- If the lamp does not come on with the switch wire connected to ground, the warning lamp is burned out or the system wiring is open circuited. Replace the lamp or service the wiring.

If the lamp stays on with the engine running and the engine has adequate oil pressure, disconnect the wire from the oil pressure switch. The lamp should go out.

- If lamp goes out, replace switch.
- If the lamp does not go out, service shorted wiring between switch and lamp.

Temperature Gauge System

- Do not apply 12 volts or ground directly to the temperature sender terminal. This voltage will damage the sender and gauge.
- Verify that the engine-to-body ground strap is secure. A poor ground can cause high temperature gauge indication.
- Idle the engine, with all the accessories off, until the thermostat opens and the engine coolant temperature stabilizes. The temperature gauge pointer should indicate in the center to lower half of the normal band. If the coolant temperature does not stabilize, check the cooling system for proper function.
- If the gauge is inoperative, or if the pointer does not indicate in the center to lower half of the normal band, test the IVR, gauge and gauge circuit with a test lamp or voltmeter.



Calibration Test—Temperature Gauge

NOTE: The electronic IVR supplies a common regulated 10 volts for temperature and fuel gauges. The IVR is malfunctioning only if all gauges show similar problems (fluctuating movement, high readings, or low readings). Refer to Section 33-20 for IVR operational test before proceeding.

Test the temperature gauge with a 19 ohm resistor for high calibration and a 250 ohm resistor for low calibration as follows:

- Turn the ignition switch to key position I or II. Connect a 19 ohm resistor between the gauge lead and ground. The center line of the pointer should fall within the band around the red sector.
- Connect a 250 ohm resistor between the gauge lead and ground. The center line of the pointer should fall within the band around the white sector.

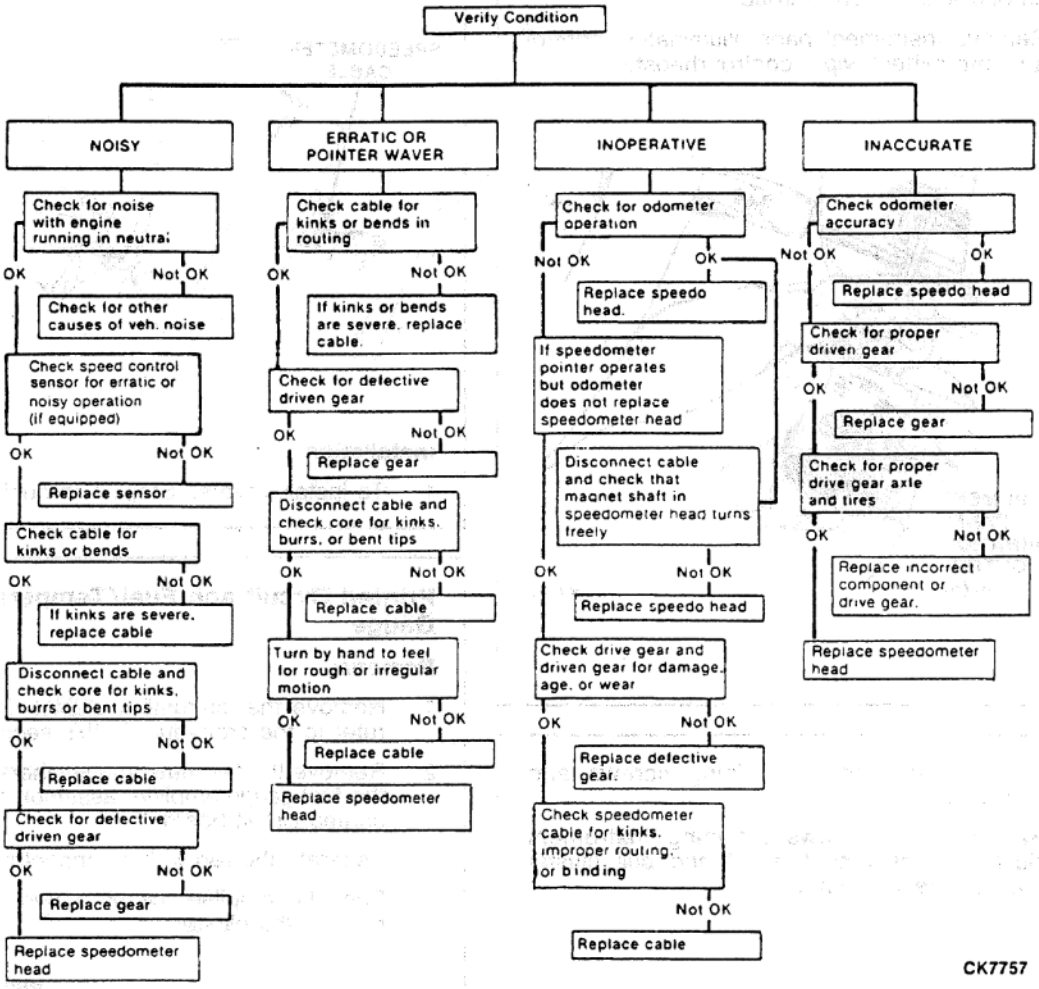
  —If the gauge tests within calibration, replace the sender.

  —If the gauge is still out of calibration, replace the gauge.

TESTING (Continued)

Speedometer/Odometer

SPEEDOMETER SYSTEM
NOISY, ERRATIC, INOPERATIVE, OR INACCURATE

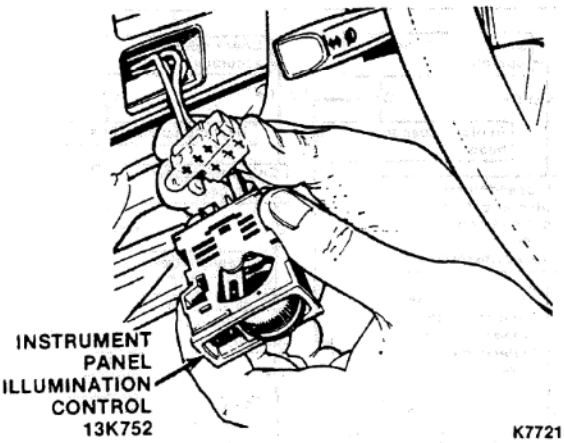


REMOVAL AND INSTALLATION

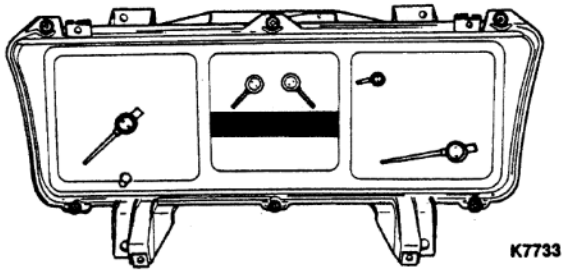
Instrument Cluster Assembly

Removal

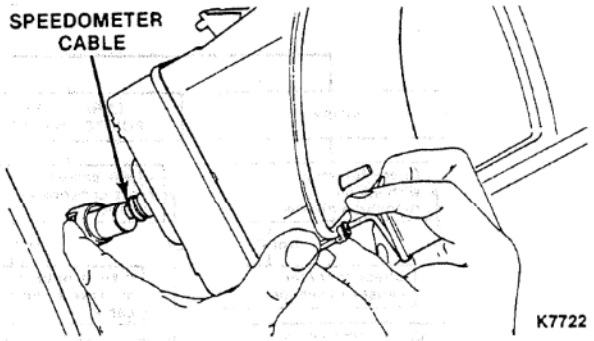
1. Remove screw from upper steering column shroud and remove shroud.
2. Remove instrument panel illumination control and intermittent wiper control rheostats.



3. Remove four bezel retaining screws and remove bezel.
4. Remove four screws retaining instrument cluster to instrument panel and pull cluster towards steering wheel.



5. Disconnect speedometer cable, harness connector, and turbo boost gauge vacuum line from rear of cluster assembly and remove cluster.



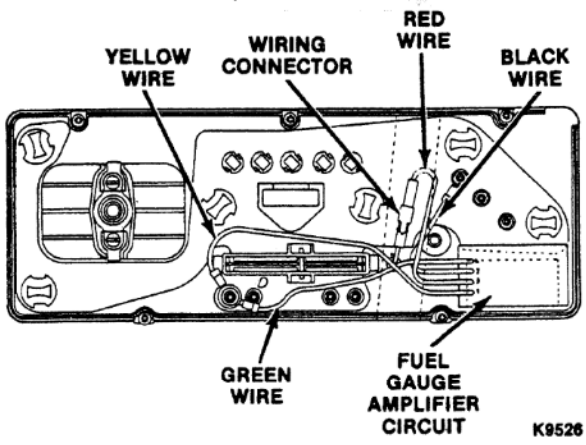
Installation

1. To install, reverse Steps 1 through 5.

Printed Circuit and Fuel/Temperature Gauge

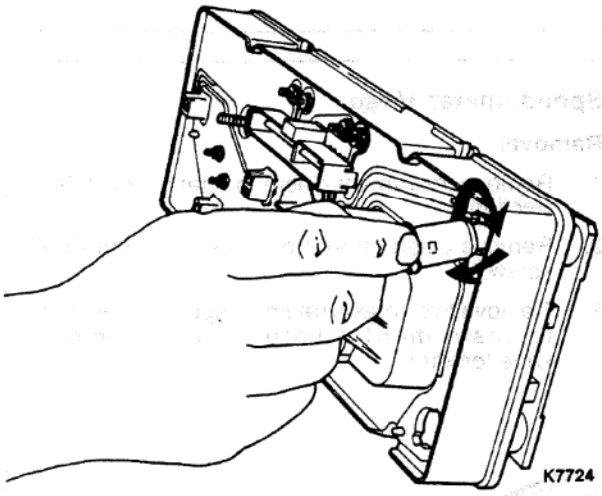
Removal

1. Remove the instrument cluster. If necessary, refer to the procedure in this section.
2. Remove the two nuts and washers connecting the fuel gauge amplifier assembly wiring to the printed circuit board.
3. Separate the red wiring connector.
4. Peel the amplifier circuit assembly from the back of the cluster.

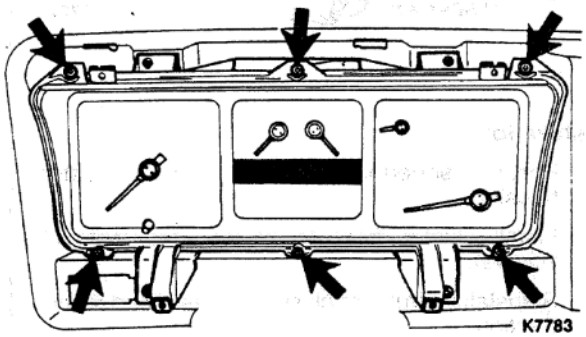


REMOVAL AND INSTALLATION (Continued)

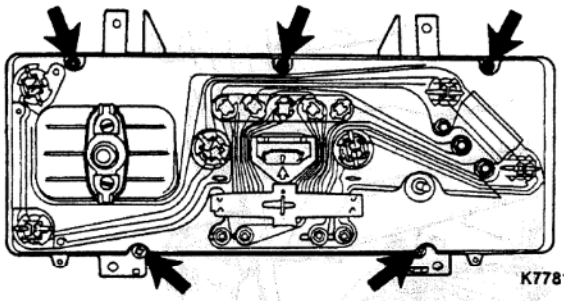
5. Remove all warning light bulbs and cluster illumination bulbs and holders. Twist bulbs counterclockwise to remove.



6. Remove six screws and detach cluster lens fascia.

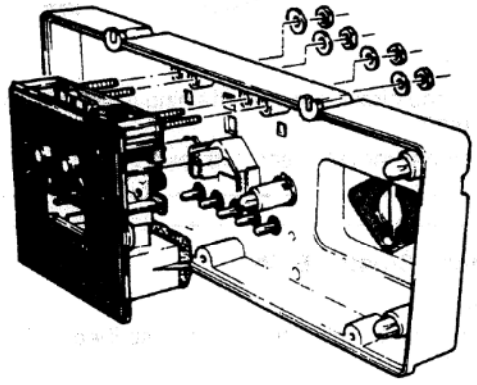


7. Remove five screws and remove cluster backplate.

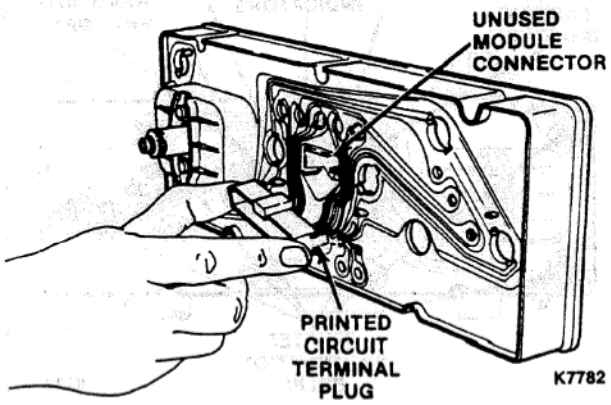


8. Remove tachometer assembly and three attaching nuts and washers.

9. Remove four nuts and washers connecting combined fuel and temperature gauge. Place gauge on a clean piece of paper or lintfree cloth to avoid soiling the gauge face.

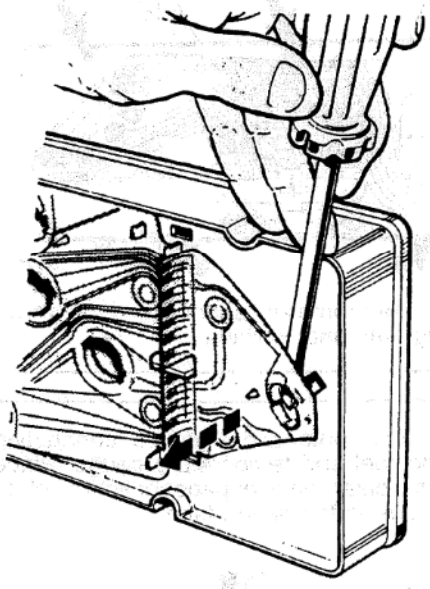


10. Remove printed circuit terminal plug connector and unused module connector.



REMOVAL AND INSTALLATION (Continued)

11. Carefully unclip printed circuit from retainers at the back of the cluster and remove printed circuit.



K7726

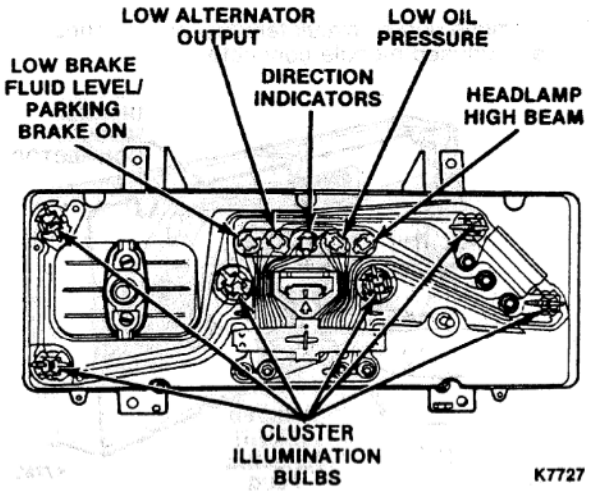
Installation

1. Fit printed circuit onto all retaining lugs on back of cluster.
2. Reverse removal Steps 1 through 11.

Instrument Cluster Bulb

Removal

1. Remove instrument cluster as described in this Section.
2. Remove bulb holder from instrument cluster. Twist counterclockwise to remove.



K7727

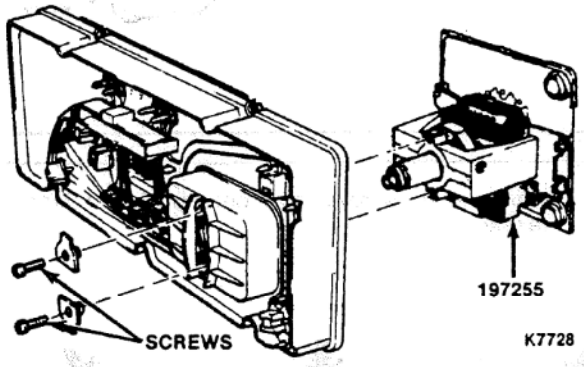
Installation

1. Fit bulb to holder and install holder in instrument cluster.
2. Reinstall instrument cluster as described in this Section.

Speedometer Head

Removal

1. Remove instrument cluster as described in this Section.
2. Remove cluster front from cluster assembly (4 screws).
3. Remove two screws retaining speedometer unit to instrument cluster body. Remove speedometer.



K7728

Installation

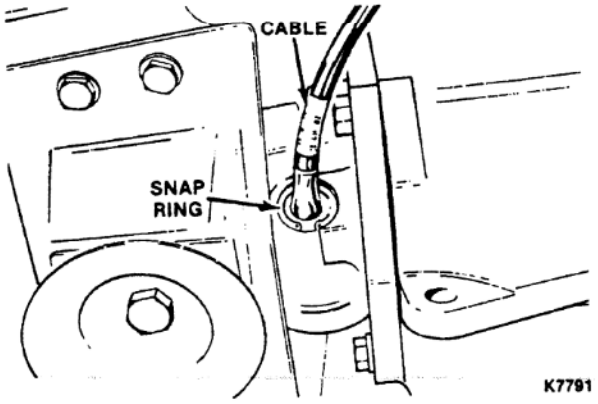
1. Position speedometer head unit in cluster housing.
2. Install cluster front to cluster assembly (4 screws).
3. Reinstall instrument cluster as described in this Section.

REMOVAL AND INSTALLATION (Continued)

Speedometer Cable

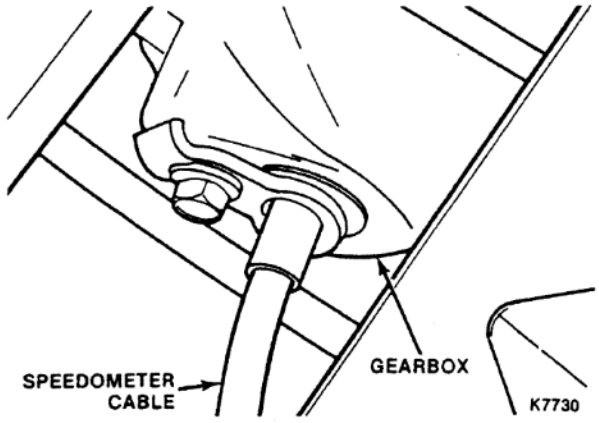
Removal

1. Remove instrument cluster as described in this Section.
2. Jack up vehicle and fit jack stands.
3. **Manual Transmission Only.** Remove snap ring holding cable to extension housing. Remove cable from gearbox.



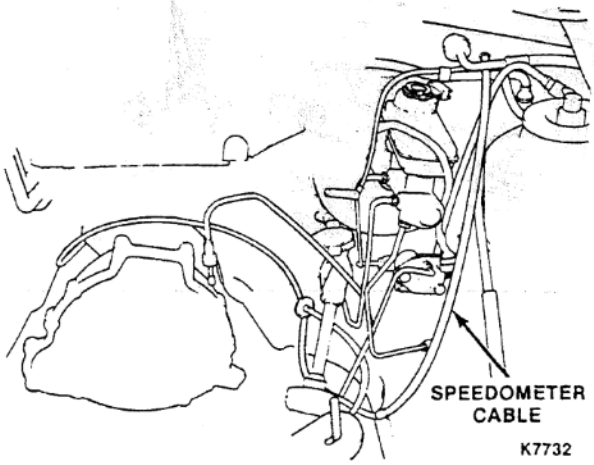
Automatic Transmission Only. Remove bolt and spring washer securing cable retaining clamp to gearbox. Remove clamp and speedometer cable.

4. Remove speedometer cable.



Installation

1. Insert cable through bulkhead aperture and fit grommet into dash panel location. Feed cable through dash panel aperture until color band on cable matches grommet. Reconnect cable to clips.
2. Route cable along side member and across bulkhead panel. Check that cable passes under side member bracket. Make sure that second color band matches first side member clip and that third color band is aligned with side member bracket.



3. **Manual Transmission Only.** Route cable to extension housing and position cable in gearbox housing driven gear. Retain with snap ring.

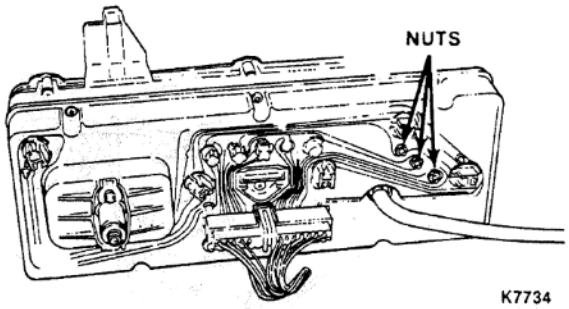
   Automatic Transmission Only. Assemble washer and clip to bolt. Position fork of clamp over speedometer cable casing. Tighten bolt from 7 to 9 N·m (5 to 7 lb-ft).
4. Remove jack stands and lower vehicle to ground.
5. Reinstall instrument cluster.

REMOVAL AND INSTALLATION (Continued)

Tachometer/Turbo Boost Gauge Assembly

Removal

1. Remove instrument cluster as described in this Section.
2. Remove cluster front from cluster assembly (4 screws).
3. Remove hose from turbo boost/vacuum gauge.
4. Remove three nuts and washers and remove tachometer from cluster.



Installation

1. Install bolt retaining turbo boost gauge pressure valve.
2. Install three nuts and washers retaining tachometer assembly to instrument cluster.
3. Install cluster front to cluster assembly (4 screws).
4. Reinstall instrument cluster as detailed in this Section.

SECTION 33-70 IGNITION SWITCH—LOCK BARREL

CONTENTS

Page

DESCRIPTION 1

TESTING

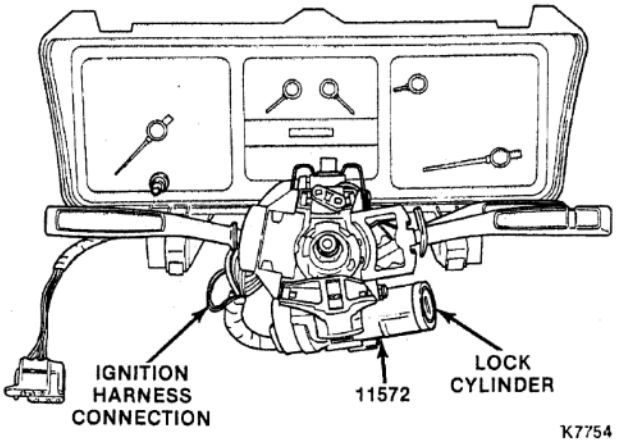
Continuity Test 2
Mechanical Test 2

REMOVAL AND INSTALLATION

Ignition Switch Lock Barrel 3

DESCRIPTION

The ignition switch is mounted onto the lock cylinder housing and is controlled by a lock barrel which is part of the actuator assembly. The lock cylinder provides a positive lock for the steering system. The locking mechanism is located in the lock cylinder housing at the upper end of the steering column. The ignition switch has a short harness connector carrying connections that engage with the connectors of a multiple connector. The multiple connector is held to the switch by integral locking fingers.



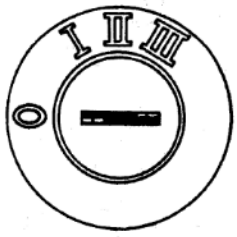
Four positions are marked on the lock:

Key Position 0:

The ignition is off and the steering wheel is locked when the key is removed. Only in this position can the key be removed.

When unlocking from position **0,** push the key in the lock and turn the key. At the same time, turn the steering wheel slightly to ease pressure on the locking device.

After removing the key, turn the steering wheel slightly until the steering lock is engaged.



WARNING: Before leaving the driver's seat, you should always make sure the gear selector lever is engaged in P (PARK) with an automatic transmission or R (REVERSE) with a manual transmission.

DESCRIPTION (Continued)

Set the parking brake fully AND shut off the ignition. Unexpected and possibly sudden vehicle movement may occur if these precautions are not taken.

Key Position I:

The steering is unlocked. The ignition remains off but the clock is displayed and the radio may be operated.

Key Position II:

The ignition and all circuits are on. This is the normal key position after the vehicle is started.

NOTE: If the vehicle is being towed, the key must be in position **II**.

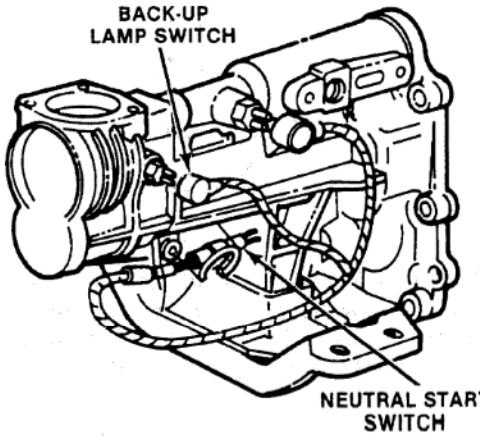
Key Position III:

The starter motor is operated. **On vehicles equipped with an automatic transmission, the gearshift selector lever must be in P (PARK) or N (NEUTRAL) for the starter motor to operate. With a manual transmission, the lever must be in the NEUTRAL position.** The engine will crank until you release the key. **If the engine does not start, the key must be returned to position I (OFF) before the starter motor can be operated again.**

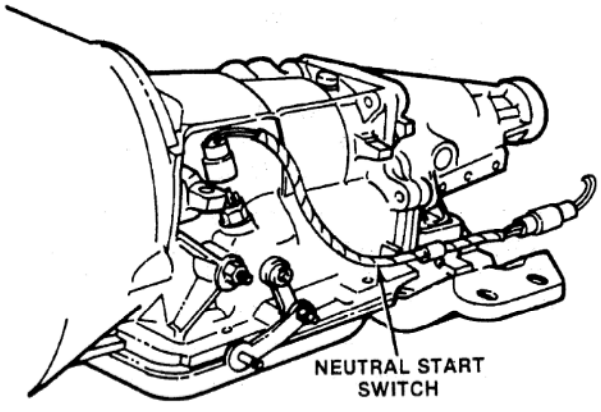
TESTING

CONTINUITY TEST

1. Disconnect the multiple connector by spreading apart the locking fingers and pulling the connector from the switch connector.
2. Test the continuity through the switch by connecting a self-powered test lamp or ohmmeter between the connector terminals indicated on the chart. No continuity should exist between any blade and chassis ground in any switch position except the proof circuit in the START position.
3. For an "engine won't crank" condition, determine if the condition exists with the shift lever in both Park and Neutral positions (automatic transmission only) or in Neutral (manual transmission) before performing the above two steps. If the "no crank" condition occurs in one shift lever position but not the other, a more probable cause is the neutral start switch located in the transmission.



MANUAL TRANSMISSION K4428



AUTOMATIC TRANSMISSION K4428

TESTING (Continued)

MECHANICAL TEST

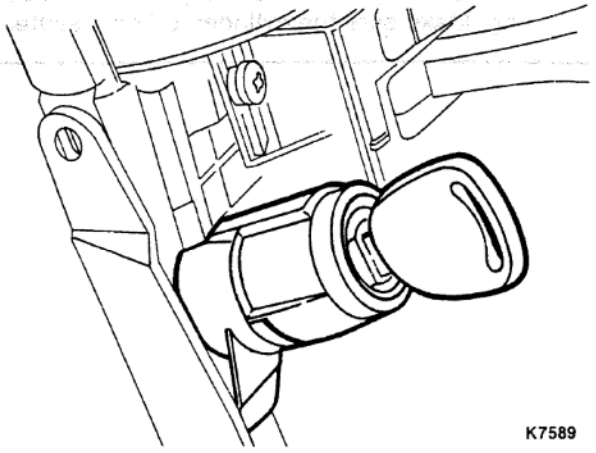
1. Test the steering column ignition system mechanical operation by rotating the lock cylinder key through all switch positions. The movement should feel smooth with no sticking or binding between detent switch positions (O, I, II, and III).
2. If sticking or binding occurs, check for the following:
   - Burrs on the lock cylinder key
   - Binding lock cylinder
   - Shroud rubbing against lock cylinder
   - Burrs or foreign material around the rack and pinion actuator in lock cylinder housing
   - Insufficient lube on actuator
   - Binding ignition switch
   - Incorrect key and poorly cut key.

REMOVAL AND INSTALLATION

IGNITION SWITCH LOCK BARREL

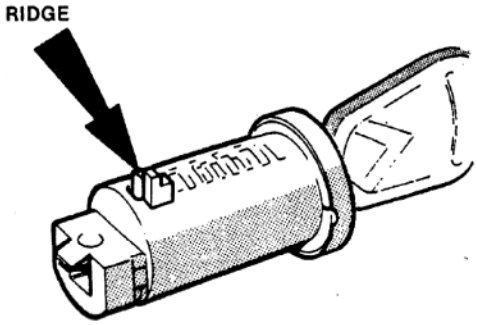
Removal

1. Remove the steering column shroud.
2. Insert the key into the ignition switch and turn the key to the ACC position (I).
3. Using a suitable tool, depress the key cylinder leaf spring through the access hole in the lock housing. At the same time, gently jiggle the key back and forth until the lock barrel and key cylinder come free.



K7589

4. Remove the circlip from the lock barrel. Be sure not to damage the circlip location in the lock barrel; otherwise, assembly of the circlip will be affected.
5. Withdraw the key approximately 5 mm (0.2 in). This will cause an additional ridge to project which acts on the key cylinder chamfer causing it to be brought flush to the barrel. Remove the key barrel from the cylinder.



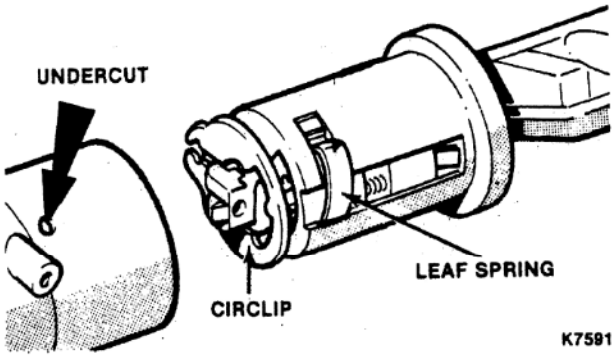
K7590

REMOVAL AND INSTALLATION (Continued)

IGNITION SWITCH LOCK BARREL

Installation

1. Insert the key fully into the key barrel; then, withdraw it approximately 5 mm (0.2 in.) to bring the additional ridge flush with the barrel notch.
2. Insert the key barrel into the cylinder. The barrel can only be fitted in one position and this allows the ridge to act on the cylinder chamfer.
3. Fully insert the key and check that the key and barrel can be turned freely.
4. Turn the key to the ACC position (I) and install the retaining circlip. The open jaws of the circlip must align with the keyway register of the cylinder.
5. Insert the cylinder assembly into the housing. Make sure the cylinder is firmly seated in the housing so the leaf spring fits into the undercut slot in the housing. It may be necessary to jiggle the key back and forth to achieve proper alignment.
6. Check the operation of the lock assembly in all positions.



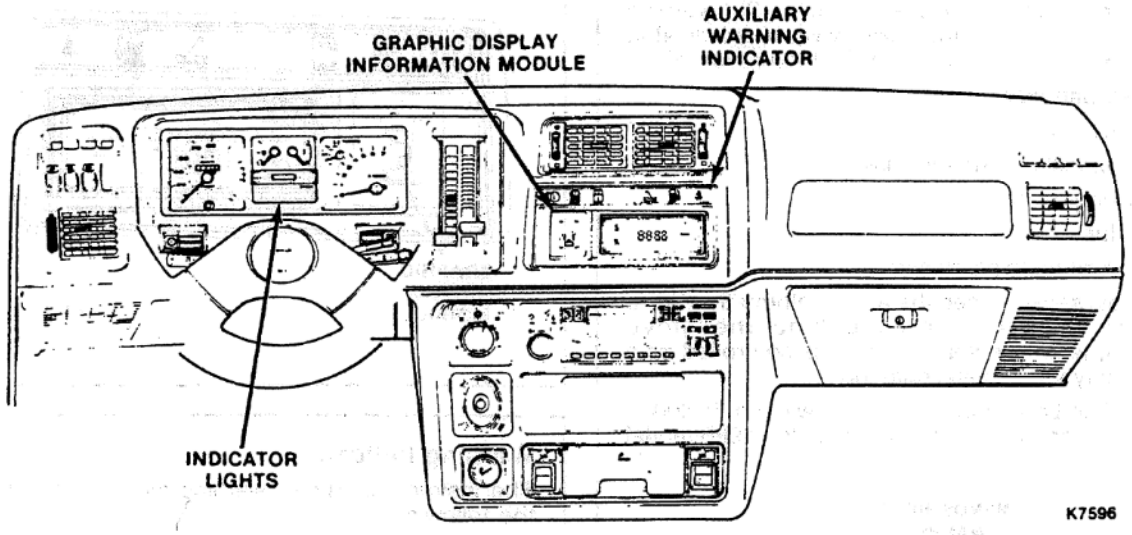
SECTION 33-92 Warning Indicator, Auxiliary Warning Indicator and Graphic Display Module

SUBJECT	PAGE
DESCRIPTION	
Auxiliary Warning Indicator	33-92-3
Graphic Display Module	33-92-4
Warning Indicator	33-92-2
DIAGNOSIS	33-92-5
REMOVAL AND INSTALLATION	
Door Ajar Switch	33-92-17
Fuel Sending Unit	33-92-15
Fuel Sending Unit	33-92-15

SUBJECT	PAGE
REMOVAL AND INSTALLATION (Cont'd.)	
Graphic Display Module	33-92-16
Low Air Temperature Sender Unit	33-92-16
Low Coolant Warning Switch	33-92-18
Low Washer Fluid Warning Switch	33-92-18
Oil Pressure Switch	33-92-17
Parking Brake Warning Light Switch	33-92-17
Stop Lamp Switch	33-92-17
Stop Lamp Switch	33-92-17

DESCRIPTION

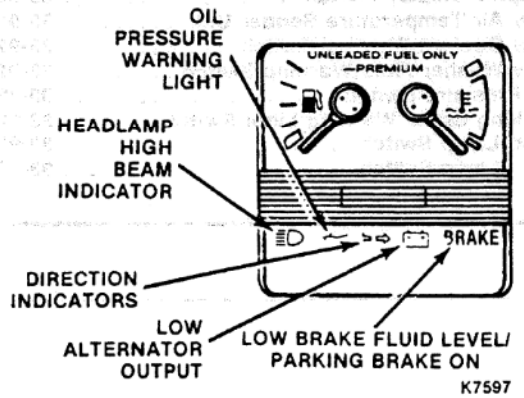
Three elements make up the warning indicator system: a warning indicator consisting of five lights located in the instrument cluster, an auxiliary warning system consisting of six warning lights located below the center dash register, and a graphic display module located left of the clock.



DESCRIPTION (Continued)

The five indicator lights located in the instrument cluster give a visual display of (from left to right):

- Headlamp high beam
- Low oil pressure
- Direction indicators
- Low alternator output
- Low brake fluid level/parking brake ON

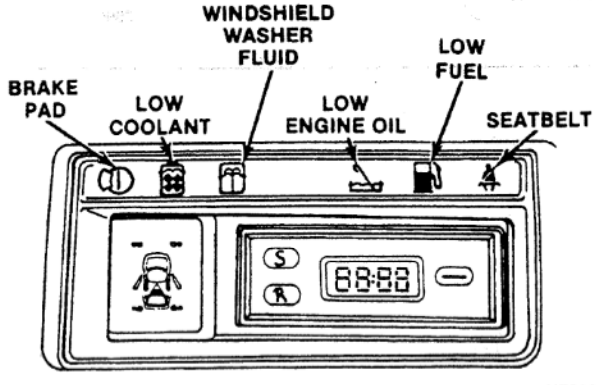


The message center contains the auxiliary warning lamps and graphic display module. Six warning lights are included in the auxiliary warning indicator. These warning lights give a visual indication of:

- Brake pad wear
- Low coolant
- Low windshield washer fluid
- Low engine oil
- Low fuel
- Seat belt warning system

Switches/sensors feed the above information into a control module located behind the glove compartment. The seat belt light is controlled by a delay relay in the fuse/relay box.

NOTE: The Low Engine Oil Lamp was not included in the auxiliary warning system after the 1986 model year.



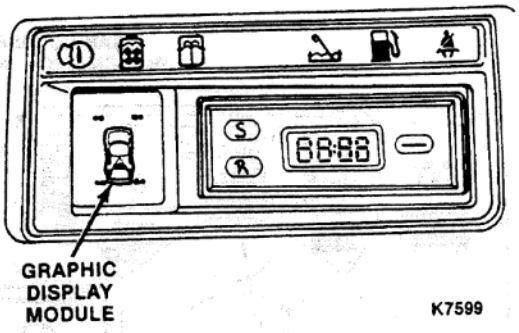
The graphic display module is located in the message center console and provides the driver with a visual indication of the following conditions:

- Low beam headlamp failure
- Parking lamp failure
- Brake/taillamp failure
- Door ajar
- Liftgate ajar
- Low air temperature warning—two warnings, one at 4°C (39°F) and one at 0°C (32°F).

NOTE: If the vehicle is equipped with a high mount stop lamp, the left rear brake lamp indicator serves a dual purpose. It will illuminate when either a high mount or left brake lamp bulb is out.

All warning lights are operable only when the ignition switch is in the II or III position.

When the ignition is switched on, the car outline in the graphic display module and the warning lights illuminate for five seconds to check bulb operation. After this time, all lights should go out in the graphic display module except for the car outline and two brake lights. The brake light warning will go out when the brake pedal is depressed if the switch, fuse, and bulb are functioning.



Warning Indicator

The instrument cluster warning indicator monitors the following:

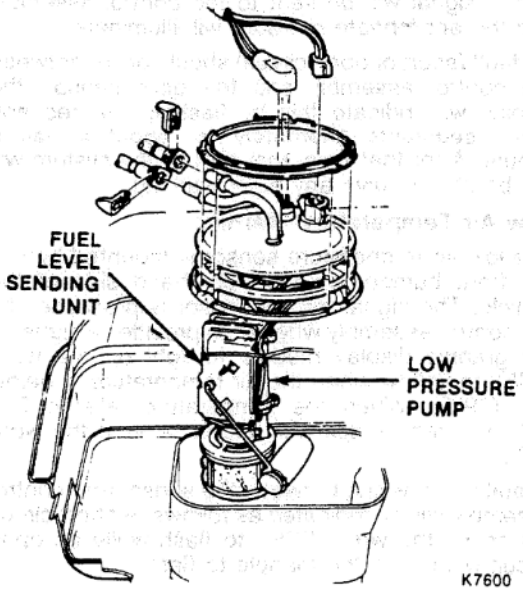
- Direction indicator warning lamp—Flashing frequency increases if an indicator bulb fails.
- Low brake fluid level/parking brake "ON"—With the ignition ON, this light will go on whenever the parking brake is applied. If the light goes on when the parking brake is not applied, the brake fluid reservoir level should be checked immediately.
- Headlamp high beam—Illuminates whenever the headlamps are on high beam.
- Low alternator output—Indicates that the battery is no longer being charged.
- Low oil pressure—Indicates inadequate oil pressure.

DESCRIPTION (Continued)

Auxiliary Warning Indicator

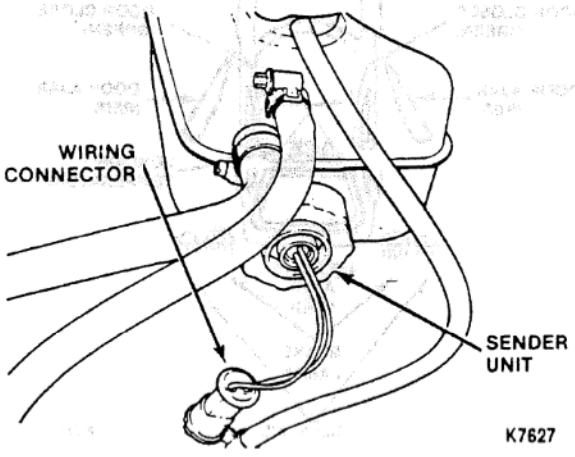
Low Fuel Warning Light

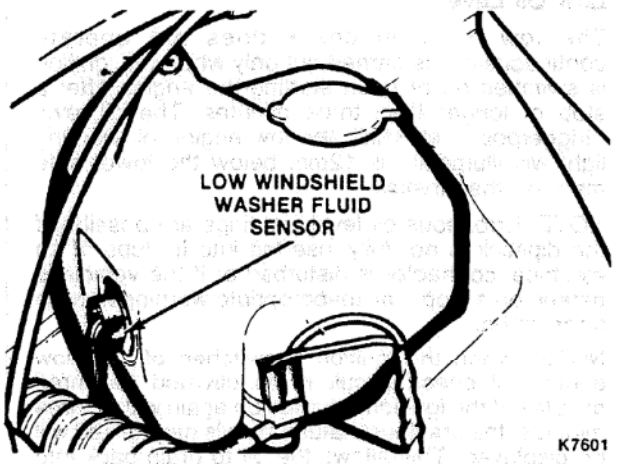
The low fuel warning light is activated when fuel remaining in the tank drops below 5.4 liters (1.4 gallons). This light is activated by a switch mounted on the fuel gauge sender unit and operated by the sender unit float.



Low Coolant and Low Washer Fluid

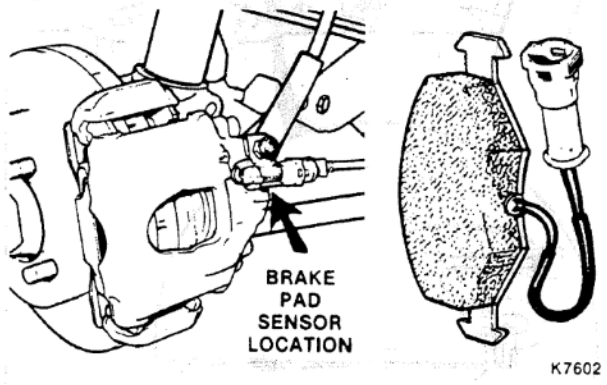
The low coolant and low washer fluid checks are obtained by float-operated reed switches inserted into the respective container. As the fluid level lowers, the float descends with the level. A magnet (mounted on the float) activates the reed switch as the float descends.





Brake Pad Wear

Worn brake pads are sensed by exposing and severing a wire loop buried in the disc pad. When a disc pad wears down to approximately 1.5mm, the wire loop is exposed to the brake disc and on further brake applications, the brake disc wears through the loop. Should the disc pad warning light illuminate and, upon checking, the disc pads are not worn, check the brake pad sensor connector. It must be clean, dry and properly connected at all times. If water contamination has tarnished or short circuited the connections, they should be dried, cleaned and reassembled. Ensure that the O-ring is properly fitted in the connector.



DESCRIPTION (Continued)

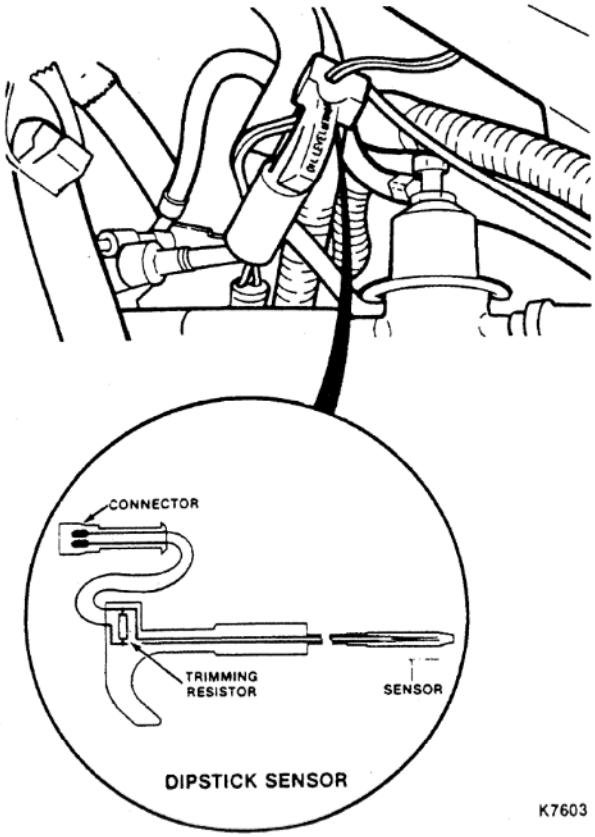
Low Oil Level

The low oil level check does not operate continuously. It is carried out only when the ignition is switched on or upon starting the engine after a stop of longer than three minutes. The oil level "triggerpoint" at which the low engine oil warning light will illuminate is 12mm below the lower safe mark on the dipstick.

NOTE: Erroneous oil level warnings are possible if the dipstick is not fully inserted into its tube. If an electrical connector is disturbed or if the vehicle is parked on a slope, an inappropriate warning may be transmitted.

NOTE: When the ignition is switched off, the low engine oil check circuit is deactivated for three minutes. If the ignition is turned on again within three minutes, the previous status which is memorized will be displayed. This allows the oil to drain back into the sump and alleviates any chance of a false low reading. After changing oil, the vehicle should not be operated and then shut off for at least three minutes. This will allow the fresh oil to drain into the sump and avoid a false reading.

NOTE: The Low Engine Oil Lamp was not included in the auxiliary warning system after the 1986 model year.



Graphic Display Module

Door Ajar Warning

With the door fully closed, the green vehicle outline will be illuminated. The sensors for the doors are mounted in the door latch assembly. They will give a "door closed" signal to the control assembly only when the door is fully closed. If the door is only pushed to or on the first position of the latch, a "door open" signal will be sent to the control assembly and the appropriate red door will illuminate.

If a fault (short or open circuit) should occur between the control assembly and the door sensor, the display will indicate this by flashing the red and green segments alternately for about a half a minute. After that time, that part of the system will not be able to give any other warning.

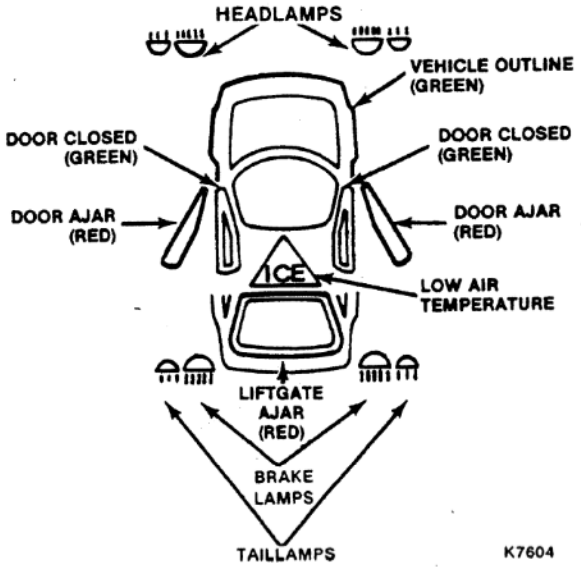
Low Air Temperature Warning

The low air temperature sensor is mounted behind the front bumper on the right hand side of the vehicle. The signal for the sensor is processed by the control assembly when then provides a signal to the graphic display module to light up the word "ICE" in yellow when the air temperature is below 4°C (39°F). When the temperature falls to 0°C (32°F), a red triangle will appear around the word "ICE."

A fault in the wiring between the sensor and control assembly will be indicated as follows. A short circuit will cause the word "ICE" to flash while an open circuit will cause the triangle to flash.

Bulb Failure Warnings

The system monitors the low beam headlamps, parking lamps, and combined tail/stop lamps.



DESCRIPTION (Continued)

The current to each bulb passes through the relay assembly/bulb outage module. The current flow is sensed in this unit. A failure of the bulb or its associated fuse will cause a signal to be sent to illuminate the appropriate segment in the graphic display module.

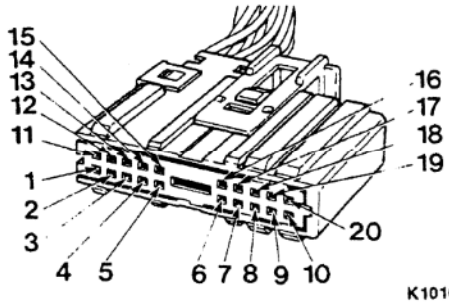
Wiring faults are not separately identified for the bulb circuits. An open circuit in the wiring will be shown as a blown bulb. A short circuit will cause the fuse to blow and this will also cause the segment to light up.

An additional feature of the stop lamp circuit is that the stop lamp switch is also checked each time the ignition is switched on. This is achieved by the stop lamp warning segment remaining illuminated after the five-second segment check until the brake pedal is depressed. The segments should then extinguish.

NOTE: The inboard secondary stop lamp is **not** monitored by the graphic display module. Only the combined dual filament tail/stop lamp bulbs and their circuit is monitored.

However, pin numbers are not embossed on the graphic display module multiplug and must be identified with reference to the below illustration.

GRAPHIC DISPLAY MODULE — MULTIPLUG



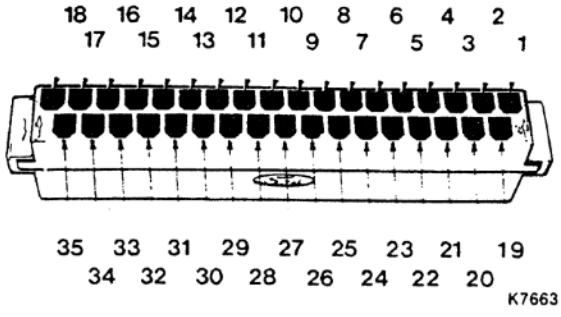
K10103

DIAGNOSIS

No special tools are required for the diagnostic checks covered in this section; however, a digital voltmeter is required. Freezer spray is required to test the low air temperature sensor. This is available only at good electronic supply stores.

The control assemblies for both the auxiliary warning system and graphic display information module are located on a bracket beneath the glove compartment. The multiplugs used are different and are color coded to prevent accidental misconnection. Pin identification numbers are embossed on the plugs for the auxiliary warning system.

AUXILIARY WARNING SYSTEM

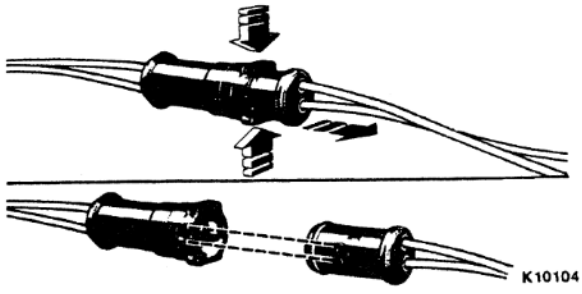


K7663

A special sensor multiplug fitment is used for the following sensors: low coolant, low windshield washer fluid, air temperature, door ajar, low engine oil and brake pads. The multiplug may contain two or three terminals depending on the type of sensor. Care must be taken when using volt/ohmmeter probes not to damage the pins of the terminals.

NOTE: The Low Engine Oil Lamp was not included in the auxiliary warning system after the 1986 model year.

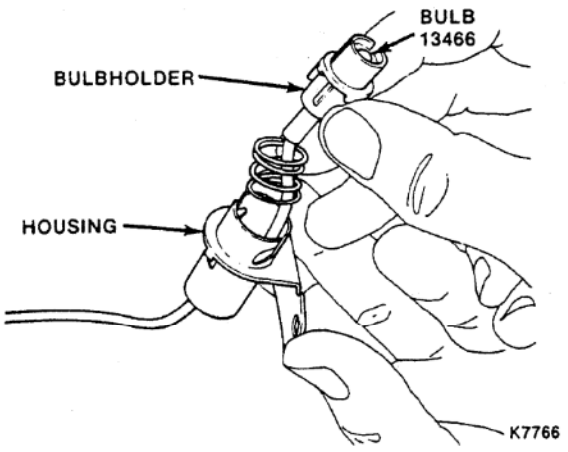
SENSOR MULTIPLUG FITMENT



K10104

DIAGNOSIS (Continued)

A special multiplug is fitted to the graphic display module and incorporates a locking device. This has to be pulled back away from the plug before the multiplug can be removed. On assembly, the locking device has to be pulled back, the plug inserted into the graphic display module, and pushed forward to lock.



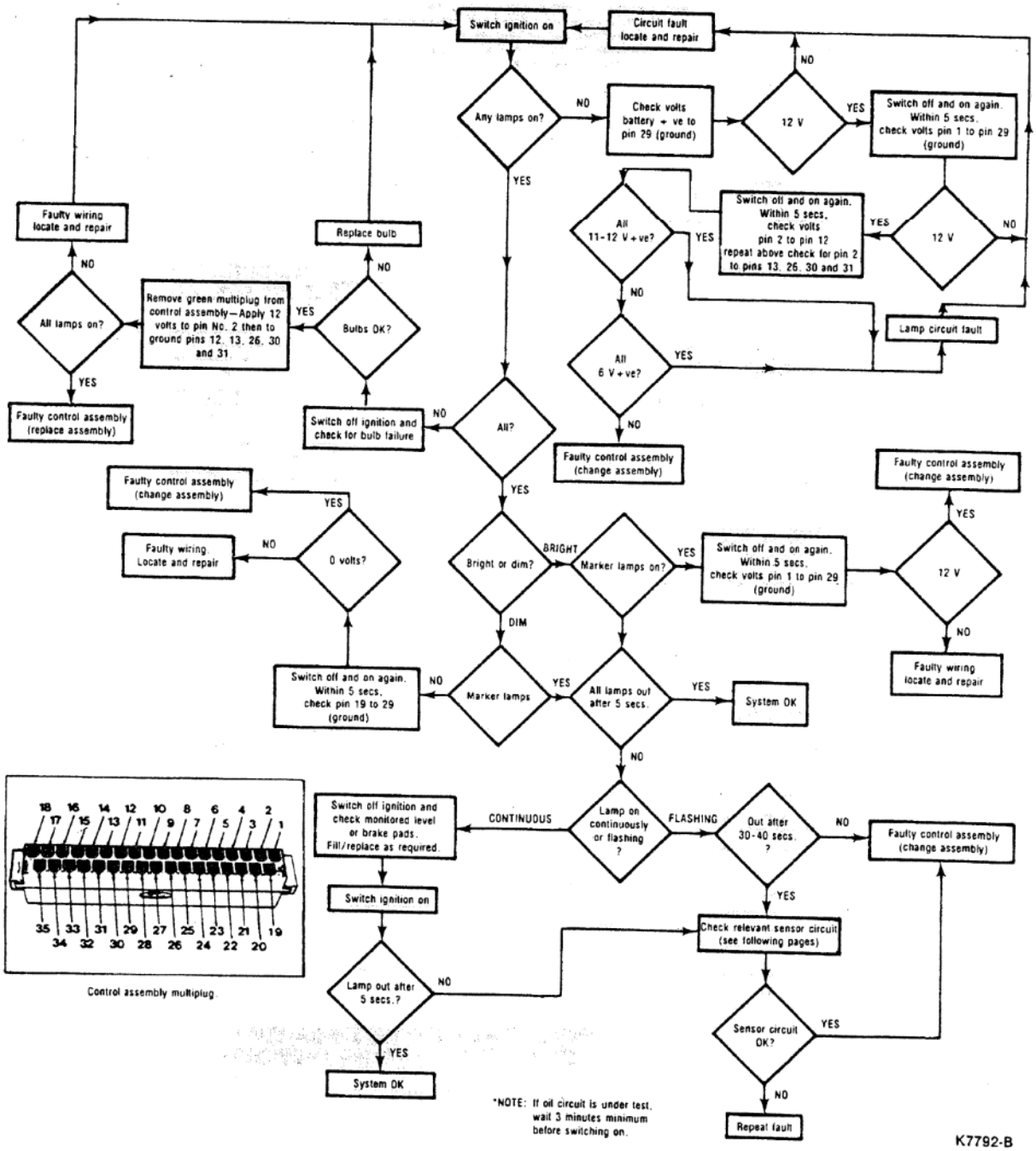
Before carrying out diagnostic checks on the auxiliary warning system, check all applicable fluid levels and brake pad wear. All the system connectors should be checked to ensure they are clean, dry and correctly mated. If the fault is still evident, proceed with the diagnostic checks included in this section.

IMPORTANT NOTE: When using the diagnostic charts, make sure that all readings taken from the control assembly are voltage only. Never use an ohmmeter to test the control assembly as substantial damage to the microelectronics could result.

DIAGNOSIS (Continued)

AUXILIARY WARNING SYSTEM LAMP CHECK

the control assembly for this check has a green insert in the multiplug connector

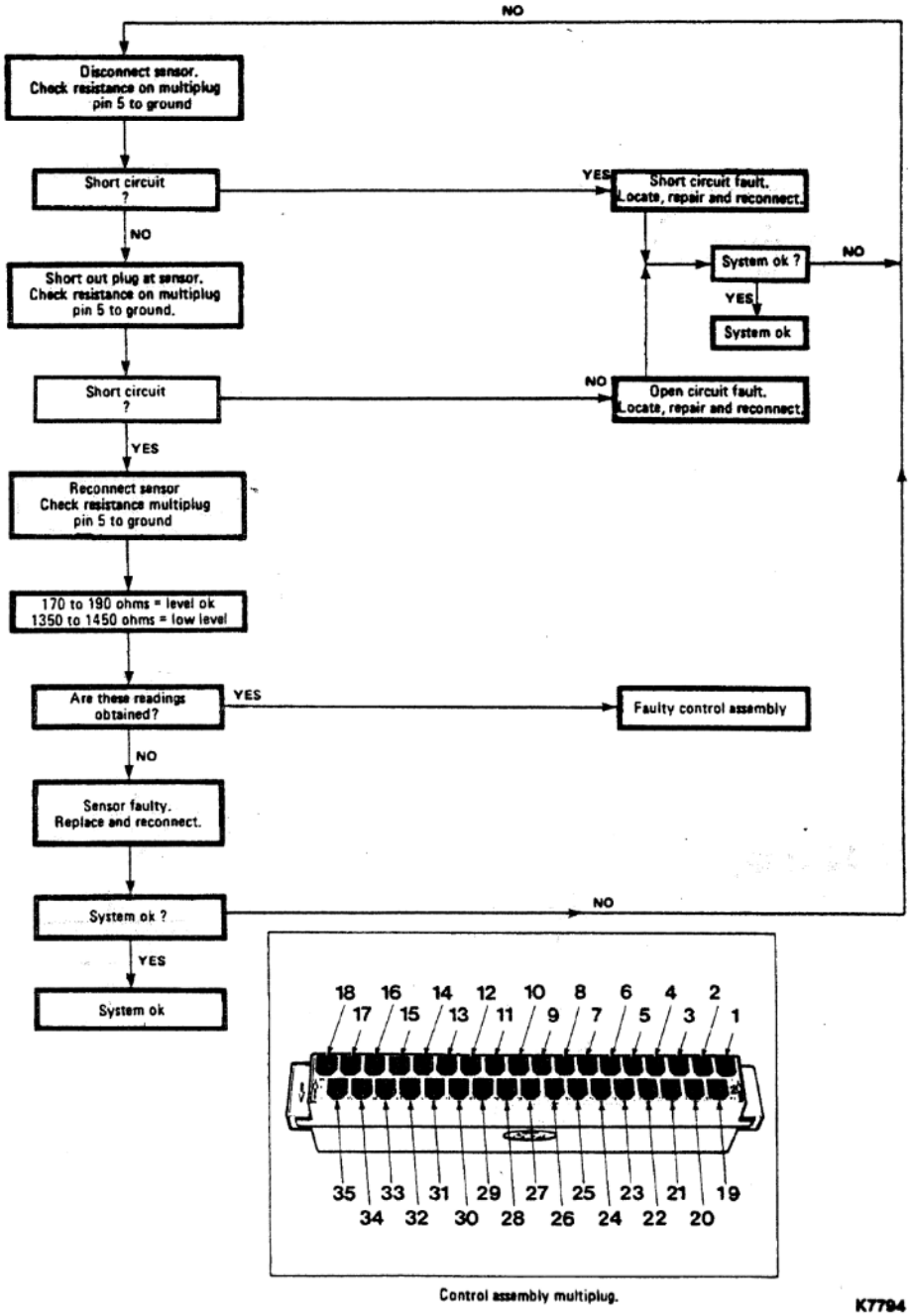


DIAGNOSIS (Continued)

AUXILIARY WARNING SYSTEM

LOW FUEL, LOW COOLANT AND LOW WINDSHIELD WASHER LEVEL SENSORS

Note: Ensure green-coded multiplug is disconnected from control assembly before commencing checks.
Low fuel sensor, as chart but read pin 4 for pin 5.
Low windscreen washer fluid sensor, as chart but read pin 21 for pin 5.
Low coolant sensor, as chart.



Control assembly multiplug.

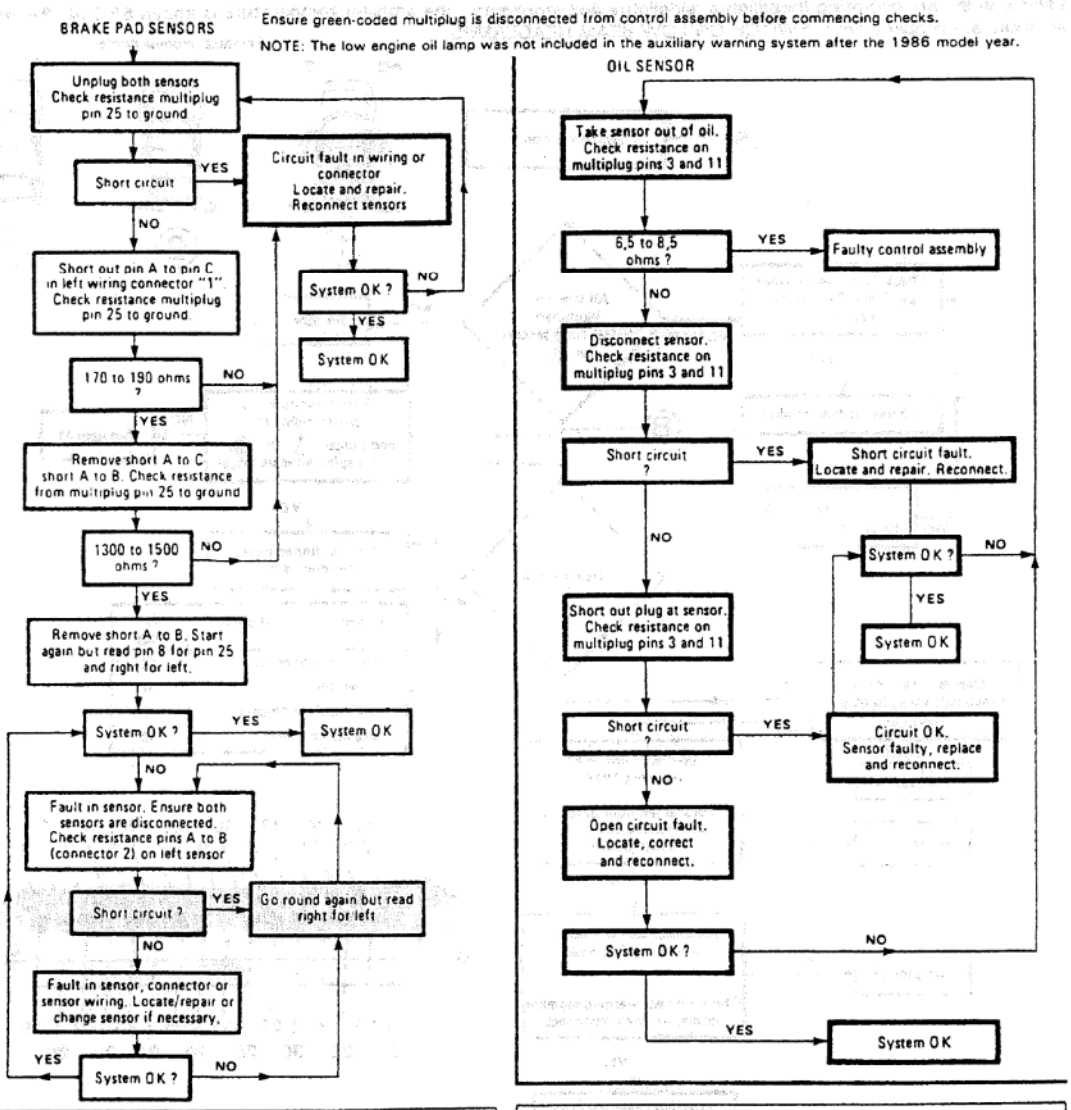
K7794

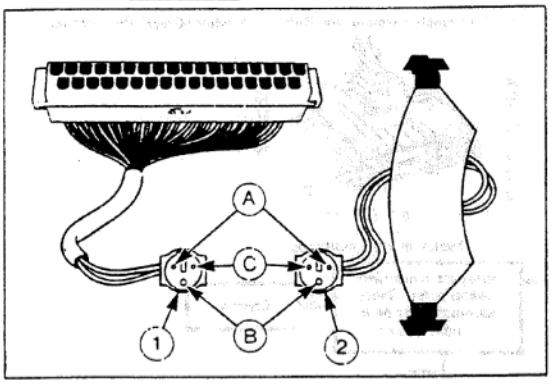
DIAGNOSIS (Continued)

AUXILIARY WARNING SYSTEM SENSOR CHECK

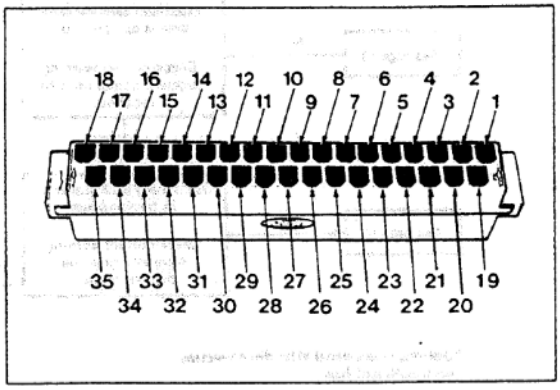
Ensure green-coded multiplug is disconnected from control assembly before commencing checks.

NOTE: The low engine oil lamp was not included in the auxiliary warning system after the 1986 model year.





Multiplug brake pad sensor and connector. Connector 1 on vehicle, connector 2 on sensor.



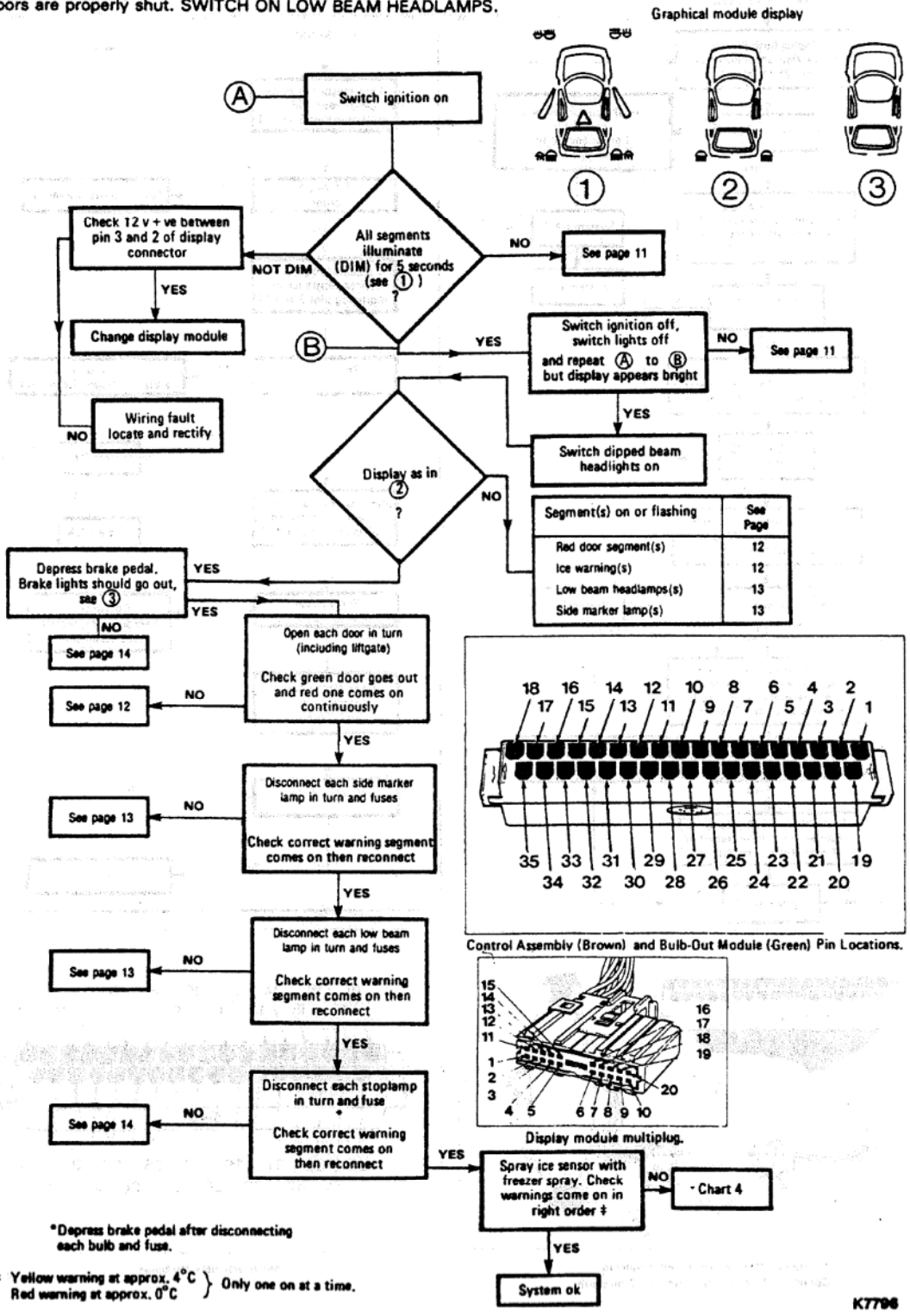
Control assembly multiplug.

K7795

DIAGNOSIS (Continued)

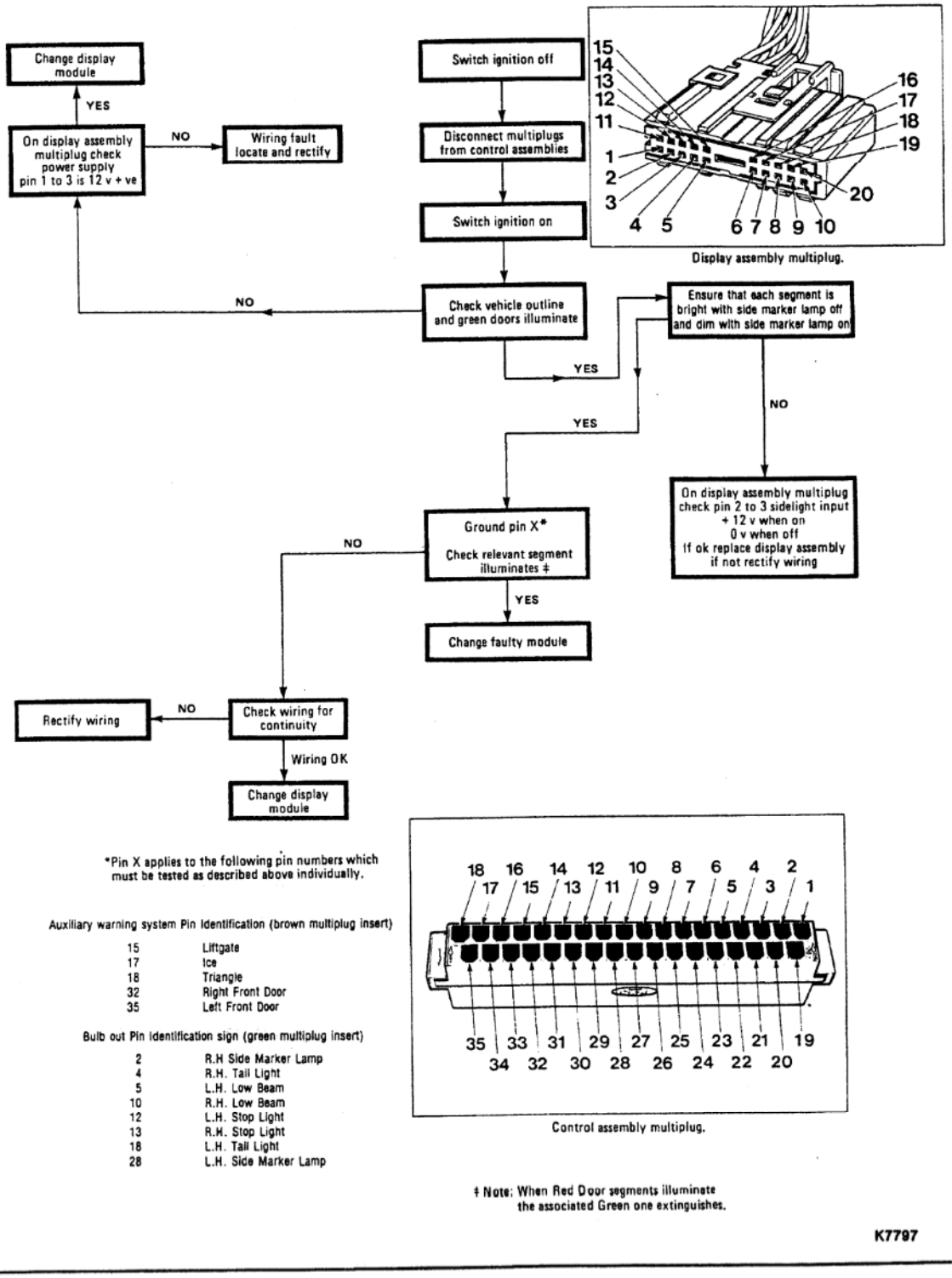
GRAPHIC DISPLAY CHECK

Before checking any complaint on the Display Assembly Warning Indicator (Graphical Display Module) ensure that all the vehicle bulbs are operating (headlights, sidelights and stoplights), the ambient temperature is above 6°C (43°F) and that all doors are properly shut. SWITCH ON LOW BEAM HEADLAMPS.



DIAGNOSIS

DISPLAY UNIT TEST



*Pin X applies to the following pin numbers which must be tested as described above individually.

Auxiliary warning system Pin Identification (brown multiplug insert)

15	Liftgate
17	Ice
18	Triangle
32	Right Front Door
35	Left Front Door

Bulb out Pin Identification sign (green multiplug insert)

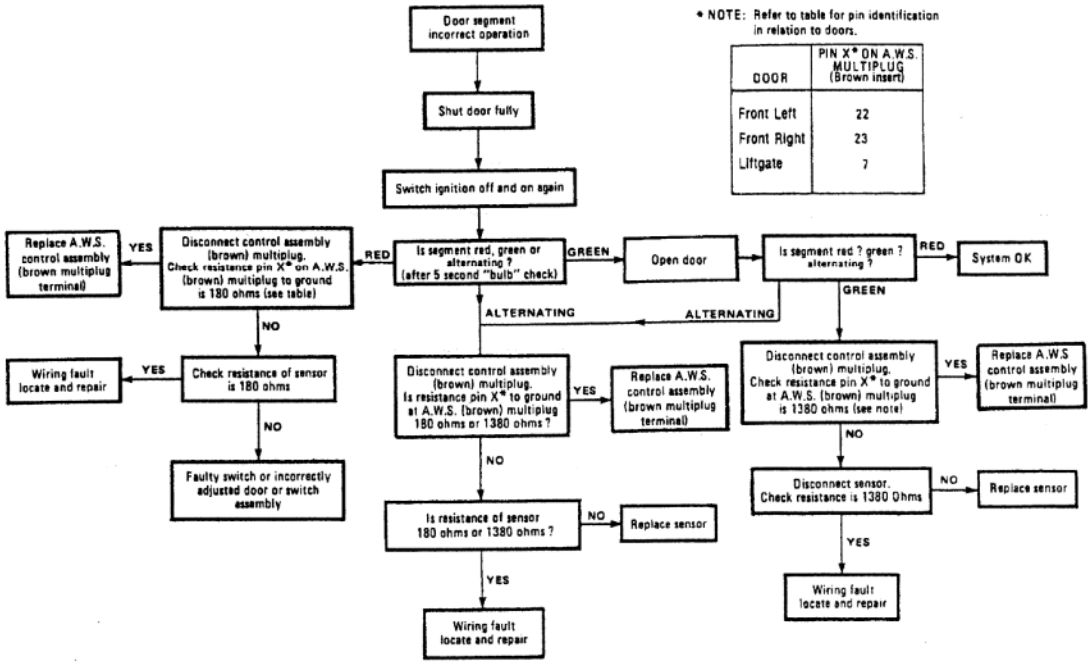
2	R.H Side Marker Lamp
4	R.H. Tail Light
5	L.H. Low Beam
10	R.H. Low Beam
12	L.H. Stop Light
13	R.H. Stop Light
18	L.H. Tail Light
28	L.H. Side Marker Lamp

‡ Note: When Red Door segments illuminate the associated Green one extinguishes.

K7797

DIAGNOSIS

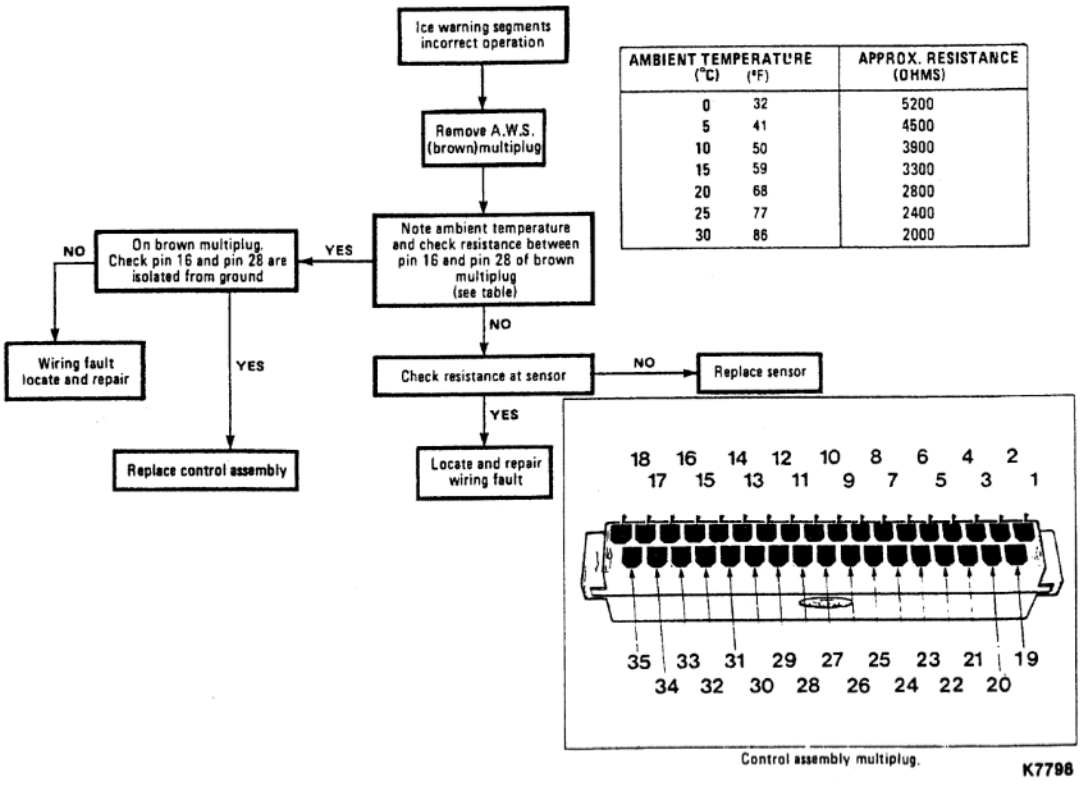
DOOR CIRCUIT TEST



* NOTE: Refer to table for pin identification in relation to doors.

DOOR	PIN X* ON A.W.S. MULTIPLUG (Brown insert)
Front Left	22
Front Right	23
Liftgate	7

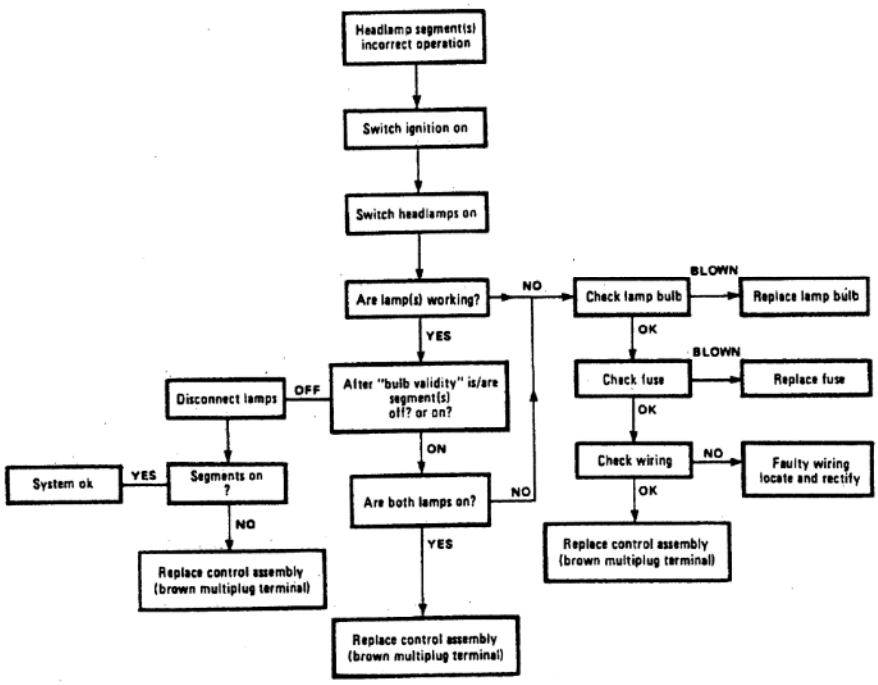
ICE WARNING CIRCUIT TEST



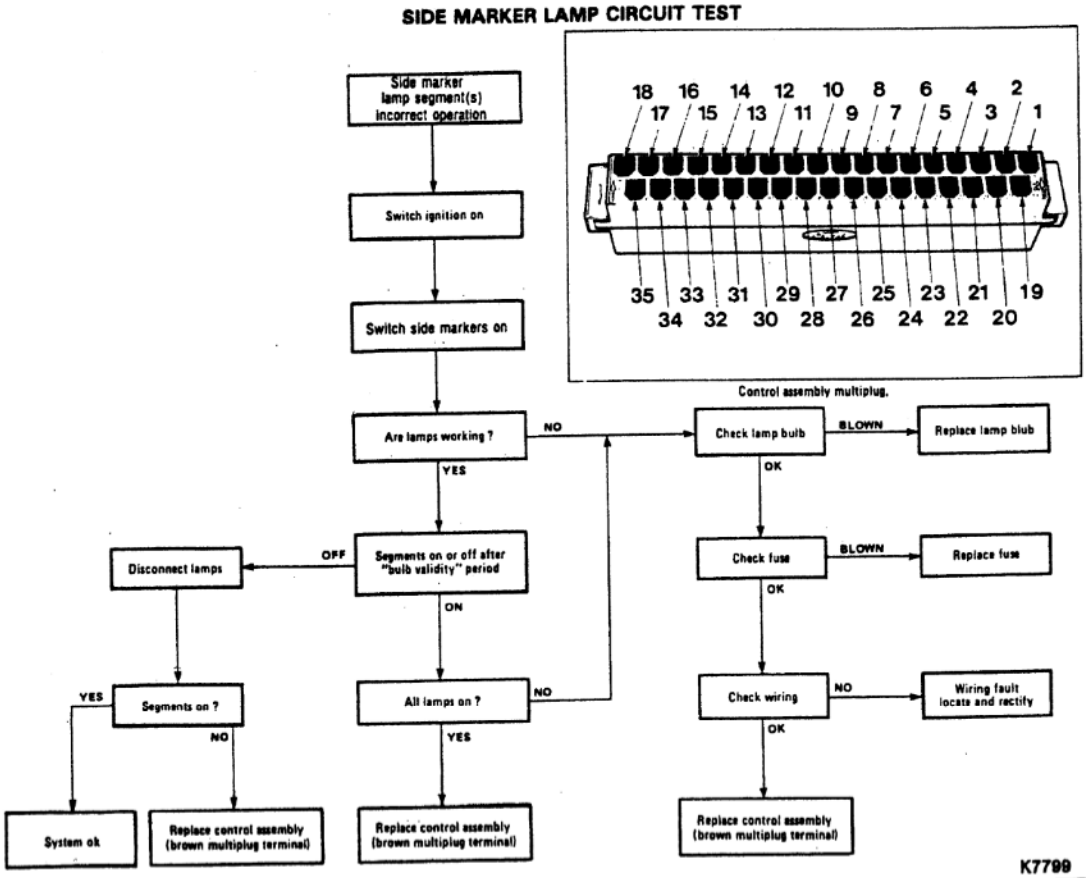
AMBIENT TEMPERATURE (°C)	(°F)	APPROX. RESISTANCE (OHMS)
0	32	5200
5	41	4500
10	50	3900
15	59	3300
20	68	2800
25	77	2400
30	86	2000

DIAGNOSIS

LOW BEAM HEADLAMPS CIRCUIT TEST

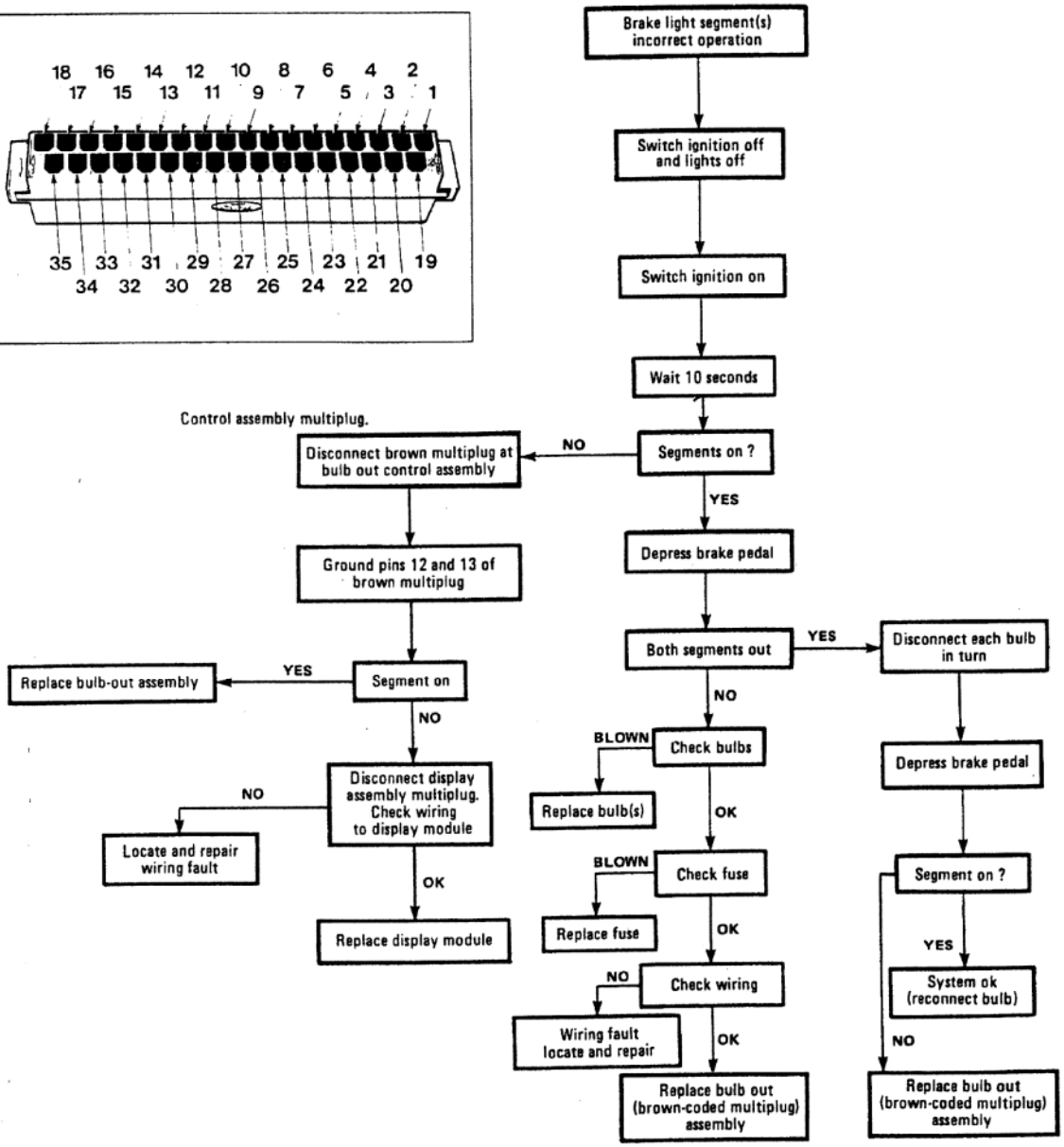


SIDE MARKER LAMP CIRCUIT TEST



DIAGNOSIS

STOP LAMP CIRCUIT TEST



REMOVAL AND INSTALLATION

FUEL SENDING UNIT

SPECIAL SERVICE TOOL REQUIRED:
Quick Connect/Disconnect Tool T82L-9500-AH
Fuel Tank Lock Ring Tool D84L-9275-A

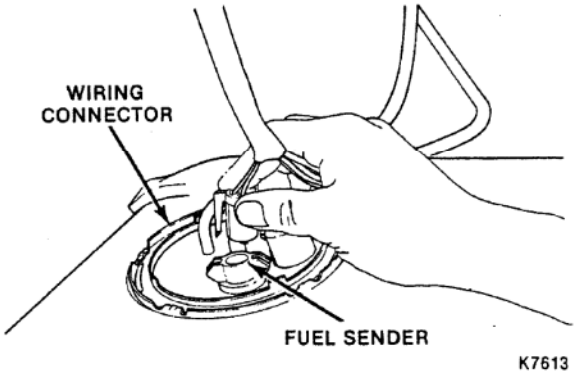
Removal

1. Remove the fuel from the fuel tank and lower the tank. Refer to Section 24-50.

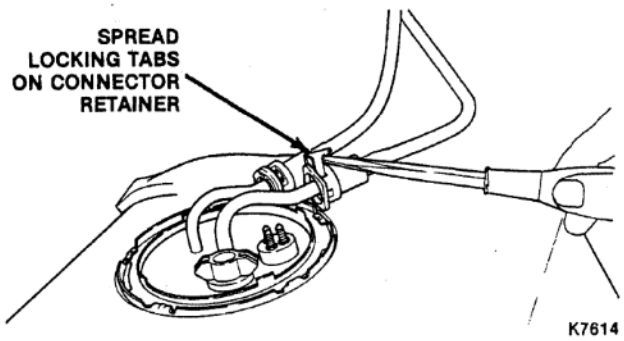
CAUTION: Be sure to depressurize the fuel system. Refer to Section 24-50.

2. Remove any dirt that has accumulated around the sending unit so that it will not enter the tank or connection.

3. Disconnect the wiring connector from the fuel sender.

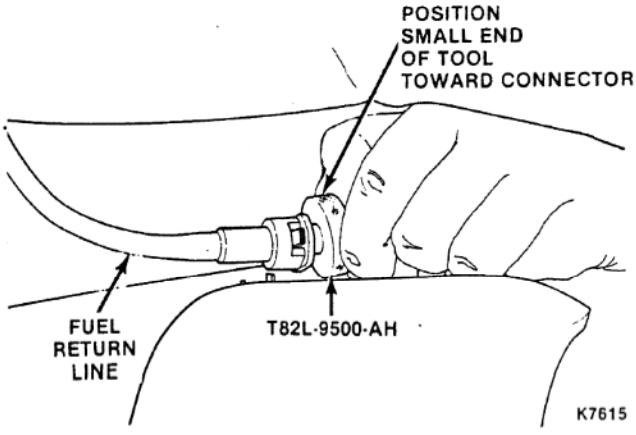


4. Remove the 5/16-inch fuel line by spreading locking tabs on the connector plastic retainer which holds the tube on the fuel sender and pump assembly. Pull the retainer from the connector and slide the connector.



5. To remove the 1/4-inch fuel return line, slide Tool T82L-9500-AH or equivalent on the steel tube with small end of the tube toward the connector. Press tool into connector to release. If connector does not release, rotate tool one-fourth turn and repeat.

6. Turn the sending unit locking ring counter-clockwise with tool D84L-9275-A and remove the locking ring, sending unit and mounting gasket.



REMOVAL AND INSTALLATION

FUEL SENDING UNIT

Installation

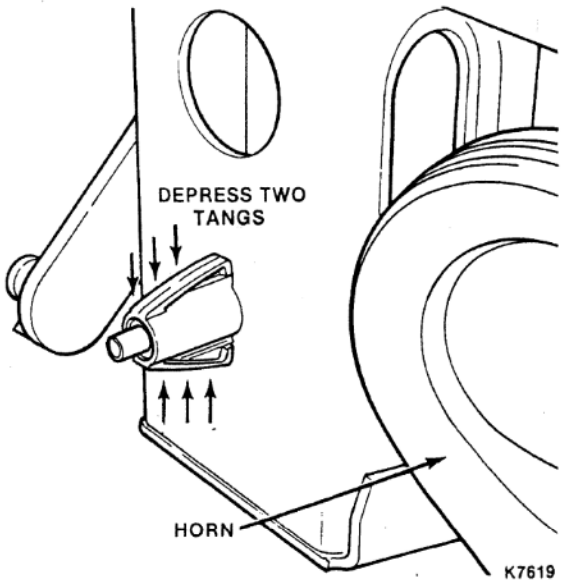
1. Clean the fuel sending unit mounting surface at the fuel tank.
2. Position a new mounting gasket and the sending unit on the fuel tank and install it by rotating the locking ring against the stop with tool D84L-9275-A.
3. Connect the wiring connector to fuel sender assembly and install clamp(s).
4. To install the 5/16-inch fuel line, install the plastic retainer in connector and push connector onto sender fitting until connector is locked onto steel tube.
5. To install the 1/4-inch fuel return line, reconnect by pushing connector onto sender fitting until connector is locked onto steel tube.
6. Reinstall fuel tank in its proper position.
7. Fill tank.
8. Check for proper fuel gauge operation.
9. Start engine and check for fuel leaks.

LOW AIR TEMPERATURE SENDER UNIT

NOTE: It may be desirable to remove the horn assembly for easy access to the sender unit.

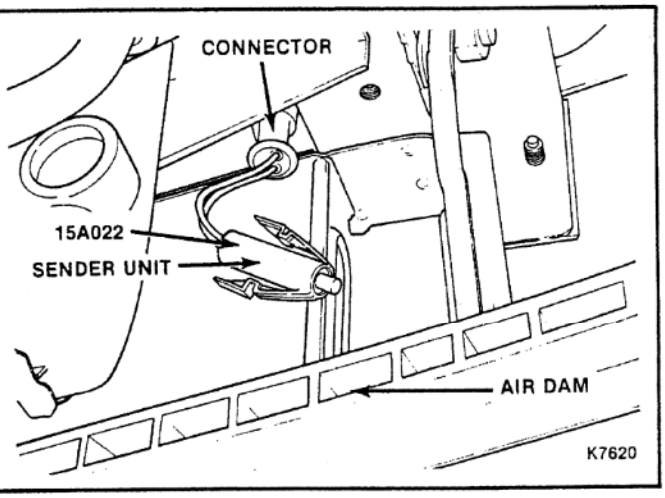
Removal

Disconnect the wiring harness, and remove the sender unit from its locating slot. Depress two tangs.



REMOVAL AND INSTALLATION

LOW AIR TEMPERATURE SENDER UNIT



Installation

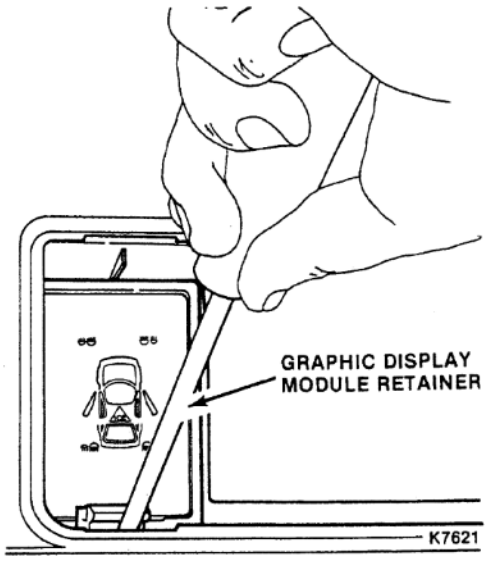
Insert the sender unit through its locating hole in the vehicle front bumper assembly. Firmly push the sender unit into the slot to seat it. Reconnect the wiring harness.

NOTE: It is important to ensure the connector is properly connected and positioned out of the way of spray thrown forward by the wheels in motion. Water ingress at the connector will prevent the "ICE" warning being sensed by the module.

GRAPHIC DISPLAY MODULE

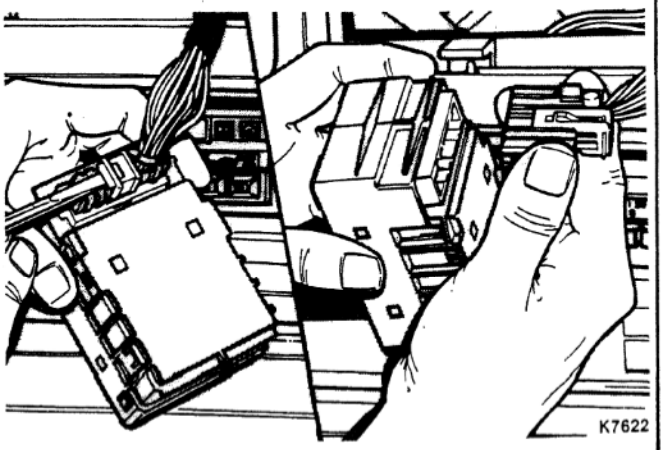
Removal

1. Disconnect the battery ground cable.
2. Remove the message center fascia and its retaining screw.
3. Remove the phillips screw from the graphic display module retainer. Remove the retainer and pull to remove the graphic display module.
4. Use a thin-bladed screwdriver to pry out the wiring harness connector retainer. Pull the connector to disconnect.



Installation

1. Reconnect the wiring harness connector and lock it in place by pushing the retainer down.
2. Install the graphic display module and module retainer. Install the phillips retaining screw.
3. Install the message center fascia and retaining screw.
4. Reconnect the battery ground cable.



REMOVAL AND INSTALLATION

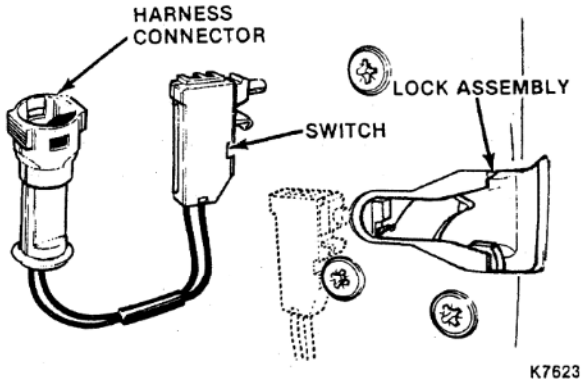
DOOR AJAR SWITCH

Removal

1. Remove the appropriate door trim panel. Refer to Section 45-03.
2. Pull switch to remove it from lock assembly and disconnect harness connector.

Installation

1. Insert switch into lock assembly and reconnect the harness connector. Check operation of the switch.
2. Install the door trim panel.



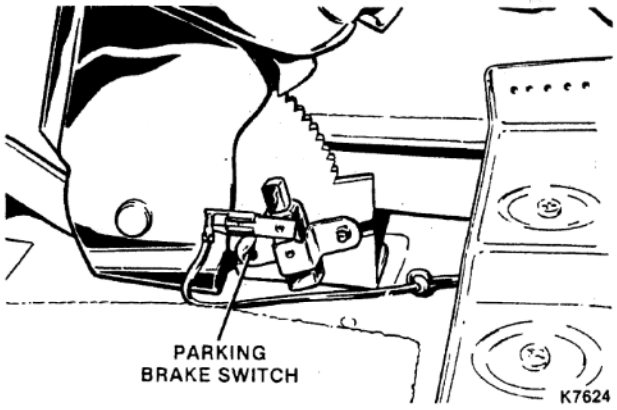
PARKING BRAKE WARNING LIGHT SWITCH

Removal

1. Remove the center console. Refer to Section 45-31.
2. Disconnect the wiring connection. Remove retaining screws and remove the switch from the parking brake lever.

Installation

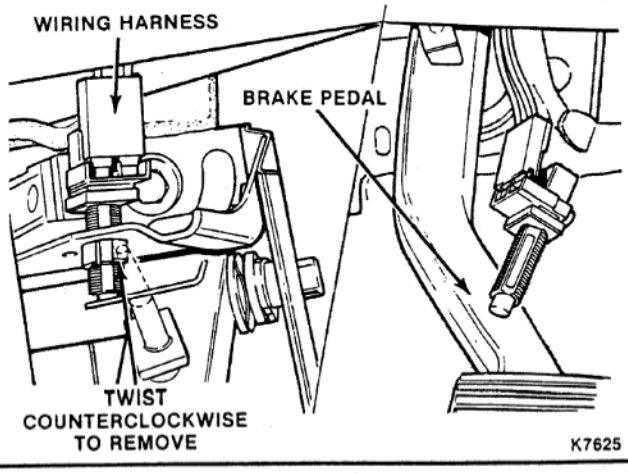
1. Install the switch on the parking brake lever and install the two retaining screws. Reconnect the wiring connections.
2. Install the center console. Refer to Section 45-31.



STOP LAMP SWITCH

Removal

1. Remove the left lower instrument panel. Refer to Section 45-61.
2. Disconnect the wiring harness at the switch. Twist the switch counterclockwise and remove.



REMOVAL AND INSTALLATION

STOP LAMP SWITCH

Installation

1. Insert the switch into the lock ring opening and push until the switch barrel touches the pedal. **Make sure the pedal is not moved from its stop.** Twist the switch clockwise to lock.
2. Reconnect the switch wiring harness and install the left lower instrument panel. Test the operation of the system.

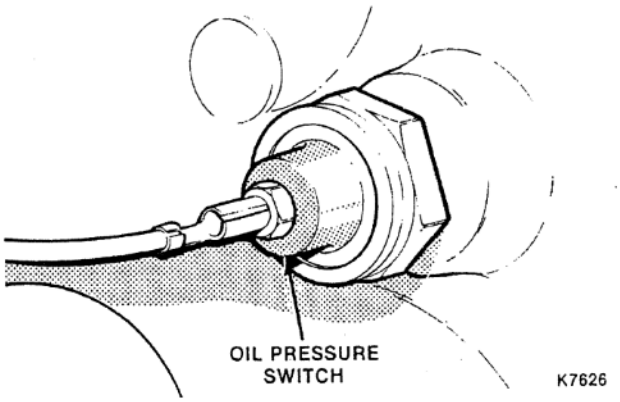
OIL PRESSURE SWITCH

Removal

Disconnect the wiring connector and unscrew the switch.

Installation

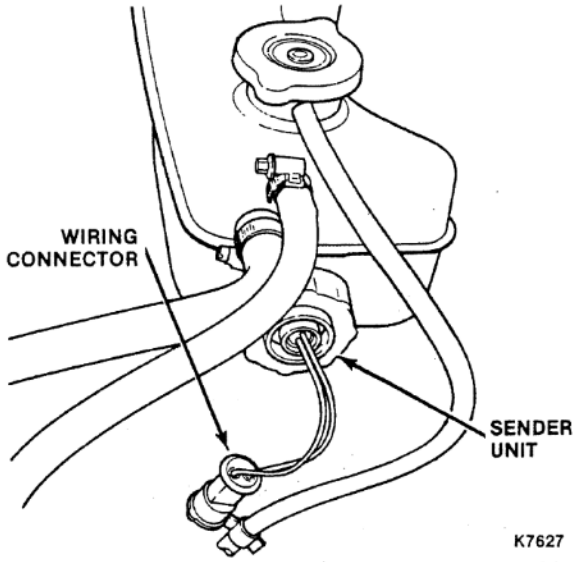
1. Screw in the switch and reconnect the wiring connector.
2. Check the engine oil level and check the operation of the oil pressure switch.



LOW COOLANT WARNING SWITCH

Removal

1. Check that the cooling system is not pressurized by slowly releasing the pressure cap.
2. Drain contents of the expansion reservoir into a clean receptacle.
3. Disconnect the harness connector and remove the switch from the tank. Do this by unscrewing the switch retainer and pulling the switch from the sealing grommet in the tank.



Installation

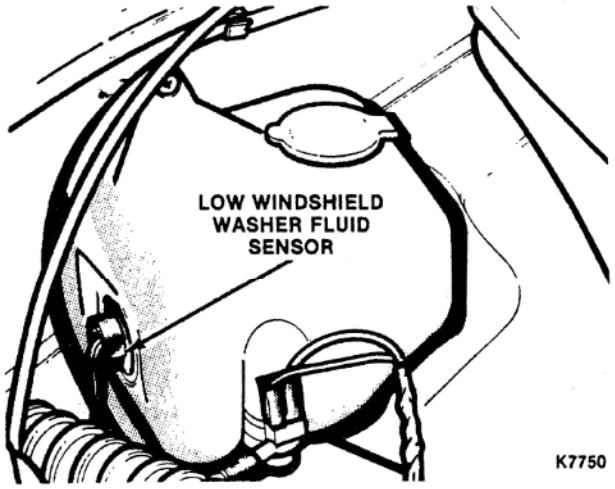
1. Make sure the sealing grommet is seated correctly. Insert the switch into the grommet and push the switch fully home. Reinstall the switch retainer.
2. Reconnect the harness connector and test switch operation.
3. Refill the expansion reservoir to specifications. Tighten pressure cap.

REMOVAL AND INSTALLATION

LOW WASHER FLUID WARNING SWITCH

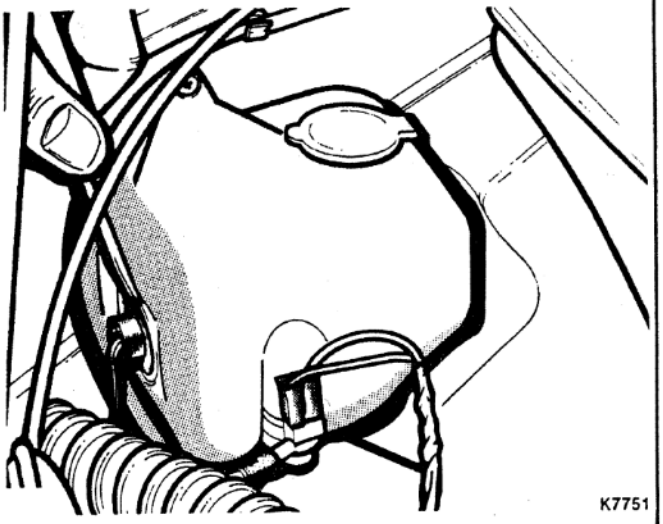
Removal

1. Disconnect connector from switch and drain or syphon contents from reservoir.



K7750

2. Remove switch from sealing grommet by gently prying the switch body with a flat-bladed screwdriver.


K7751

Installation

1. Ensure sealing grommet is correctly seated. Push switch fully into sealing grommet.

2. Reconnect switch connector and refill reservoir. Test operation.

WIRING HARNESS, ELECTRICAL CONNECTORS, CIRCUIT PROTECTION

GROUP 34 (14000)

TITLE SECTION	PAGE NO.	TITLE SECTION	PAGE NO.

WIRING HARNESS—MAIN HARNESS 34-01

REMOVAL AND INSTALLATION 1

WIRING HARNESS—ENGINE 34-20

DESCRIPTION 1
REMOVAL AND INSTALLATION 1

FUSES, RELAYS AND WARNING SYSTEMS 34-30

DESCRIPTION
- Warning Buzzer Locations 1

REMOVAL AND INSTALLATION
- Fuses and Relays 4
- Fuse Link Replacement 4

DIAGNOSIS AND TESTING
- Fuse Link Continuity Test 4

SERVICE PROCEDURES
- Fuse Link 5

SECTION 34-01 WIRING HARNESS—MAIN HARNESS

CONTENTS

Page

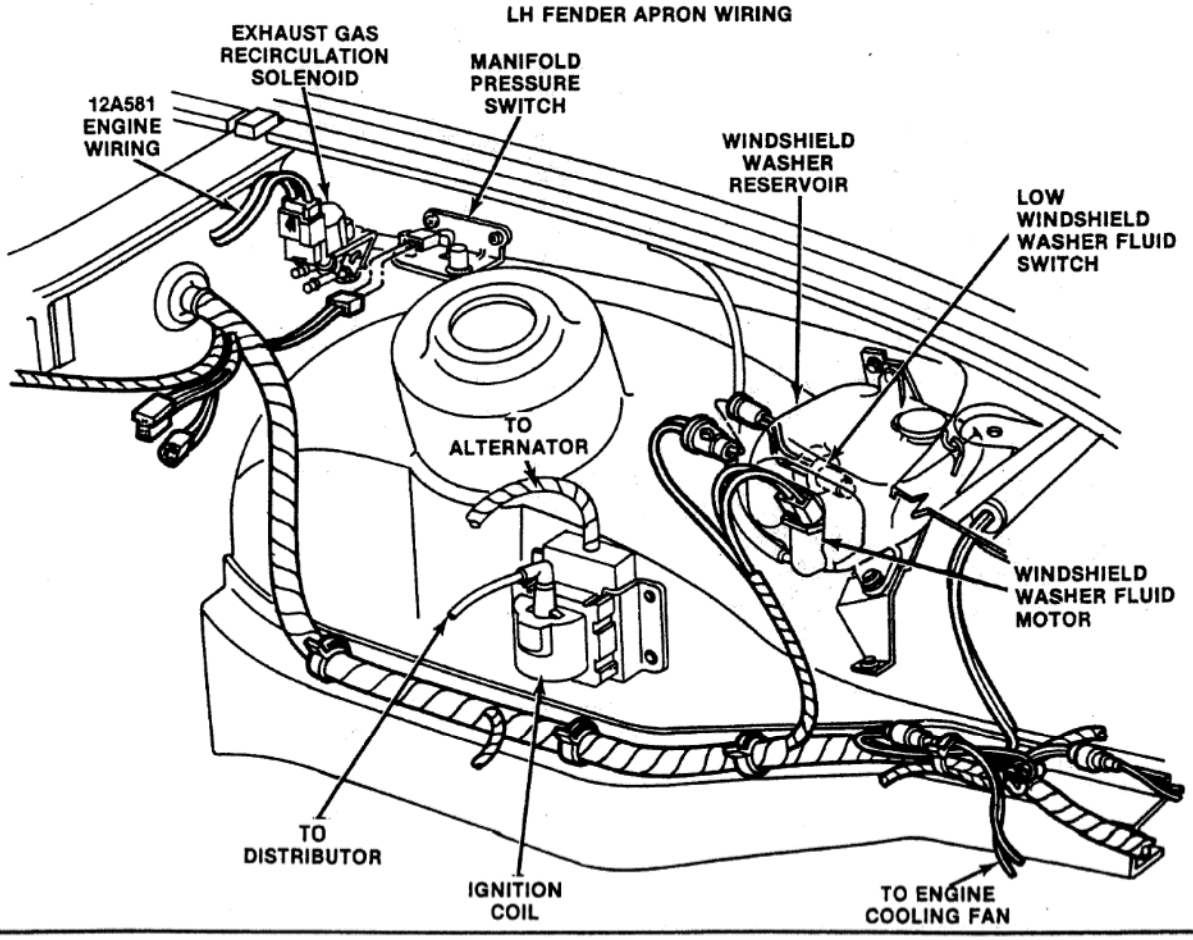
REMOVAL AND INSTALLATION 1

REMOVAL AND INSTALLATION

BASE HARNESS WIRING HARNESS

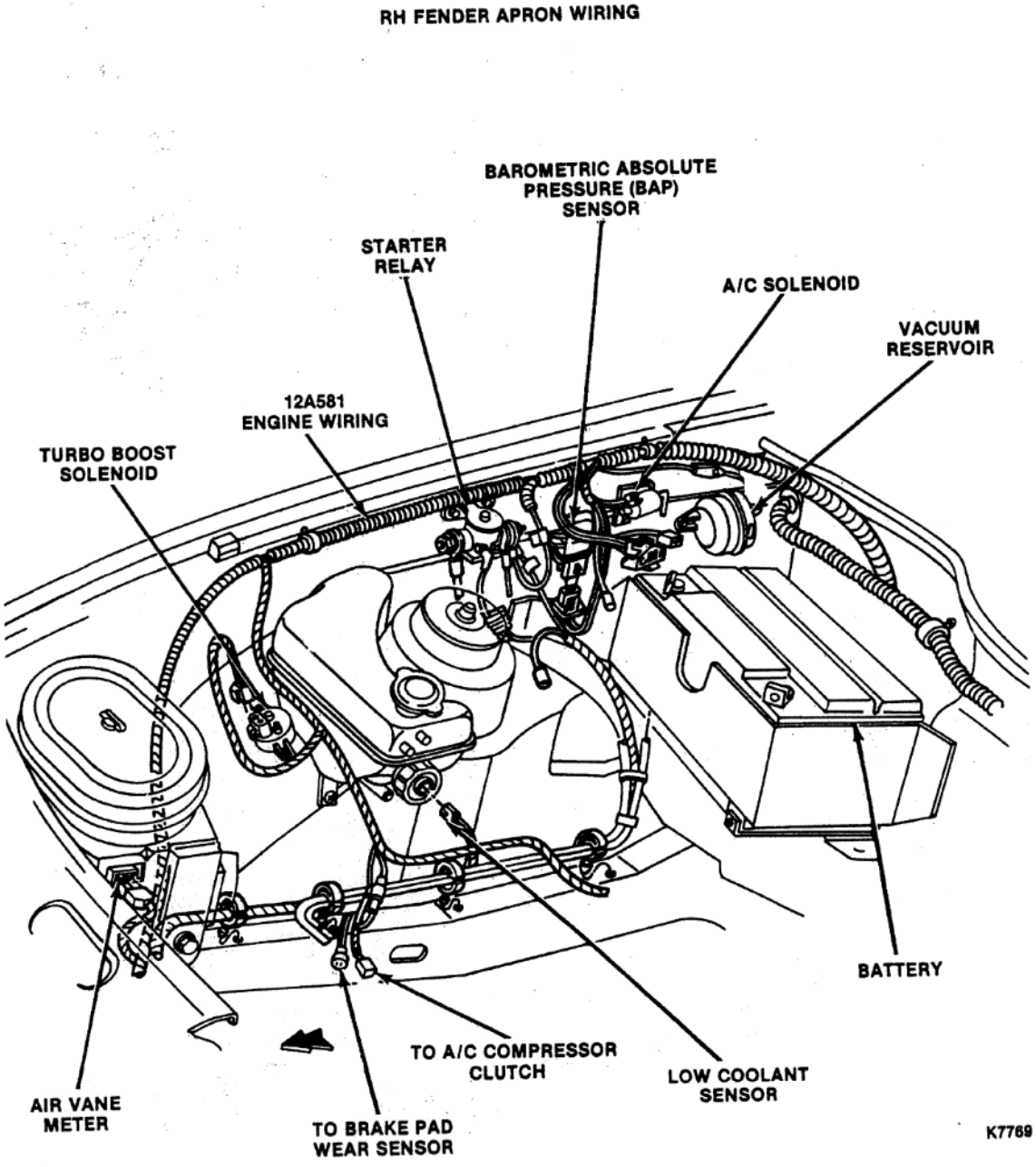
Removal

1. Disconnect the negative battery cable.
2. In the engine compartment, disconnect all connectors and harness retainers that are part of the main wiring harness assembly.



REMOVAL AND INSTALLATION (Continued)

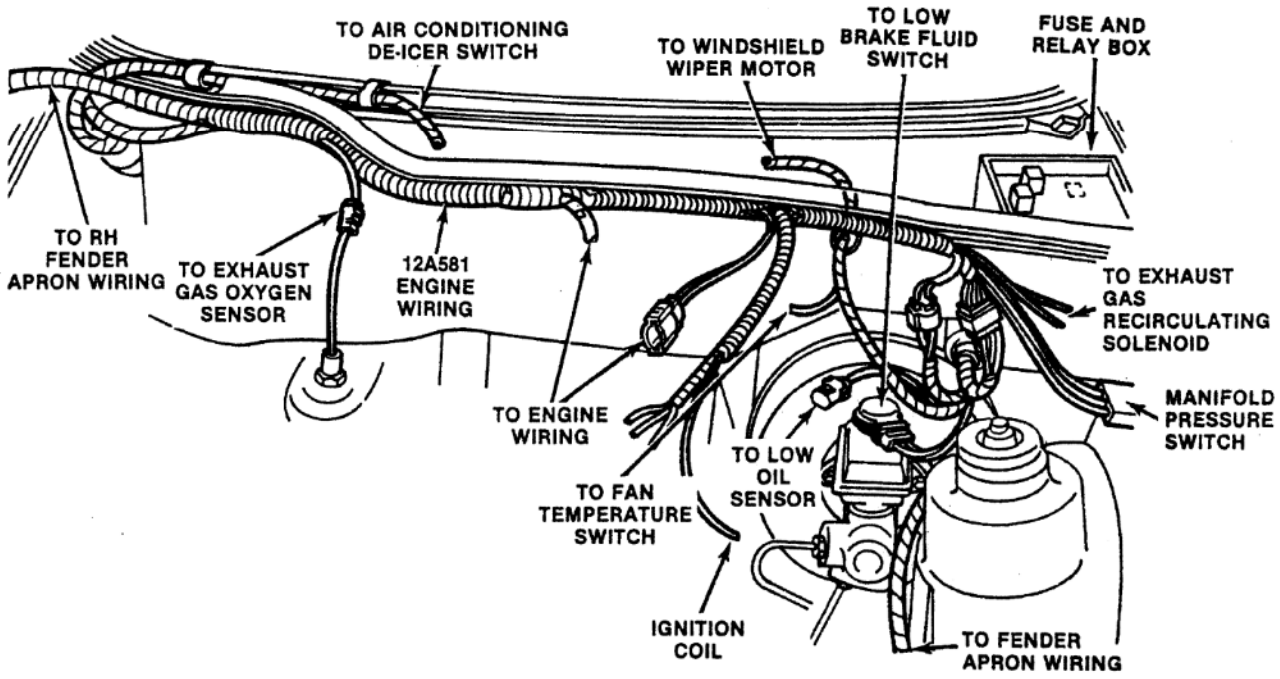
BASE HARNESS WIRING HARNESS (Continued)



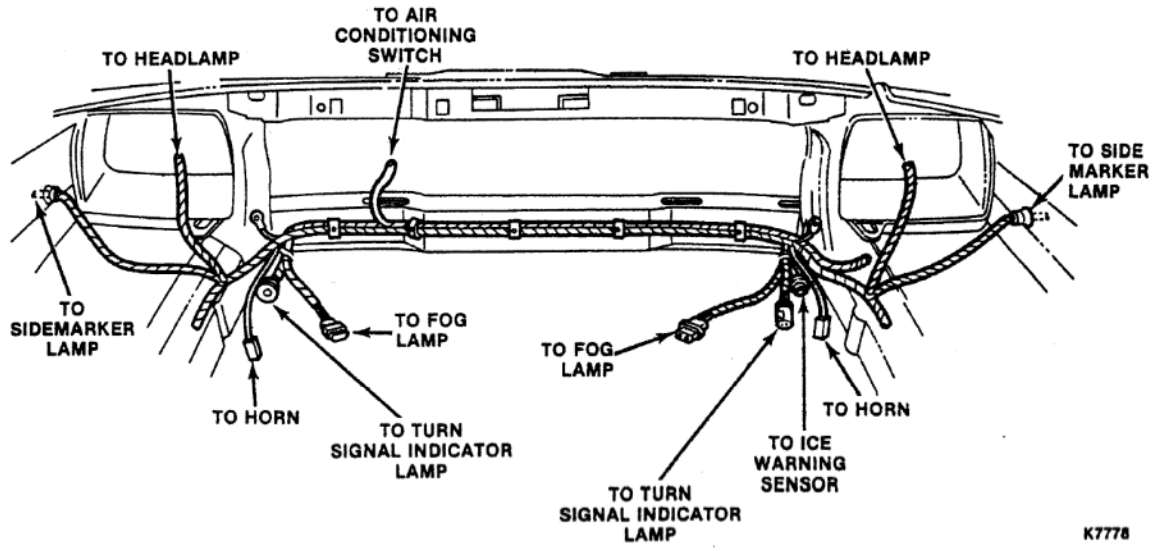
REMOVAL AND INSTALLATION (Continued)

BASE HARNESS WIRING HARNESS (Continued)

DASH PANEL WIRING



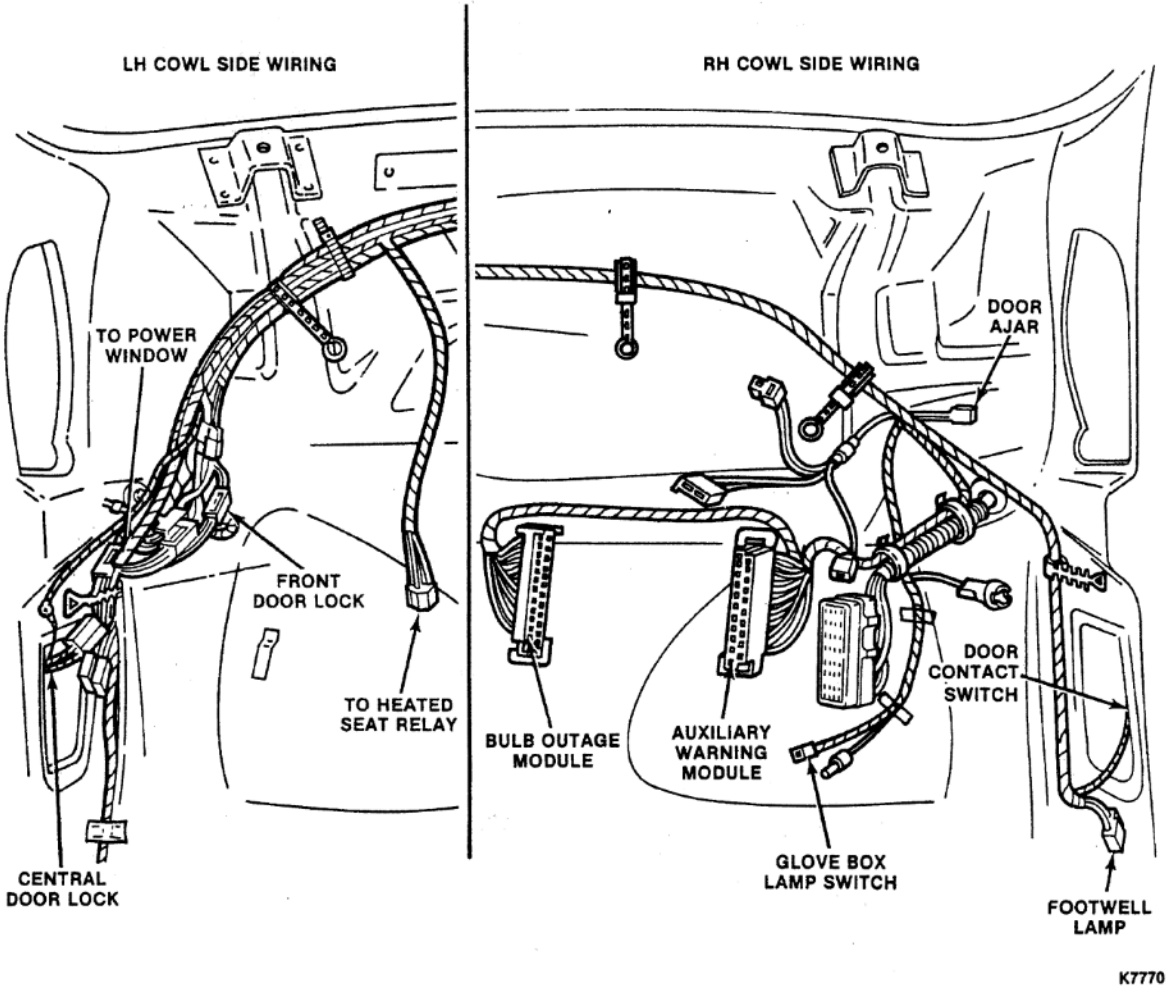
FORWARD ENGINE COMPARTMENT WIRING



REMOVAL AND INSTALLATION (Continued)

BASE HARNESS WIRING HARNESS (Continued)

3. Remove the left and right cowl side trim panels. Refer to Section 45-03. In the cowls, disconnect all connectors that pertain to the main wiring harness assembly.

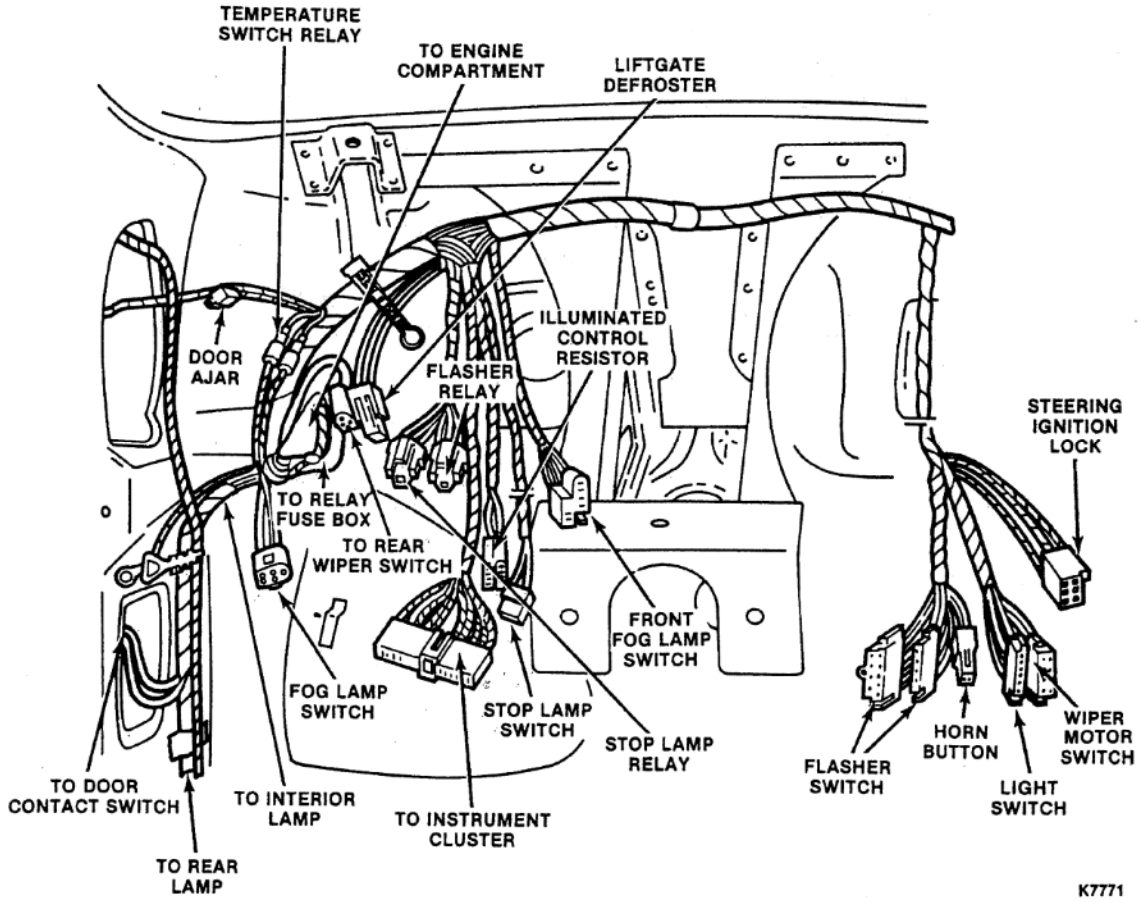


REMOVAL AND INSTALLATION (Continued)

BASE HARNESS WIRING HARNESS (Continued)

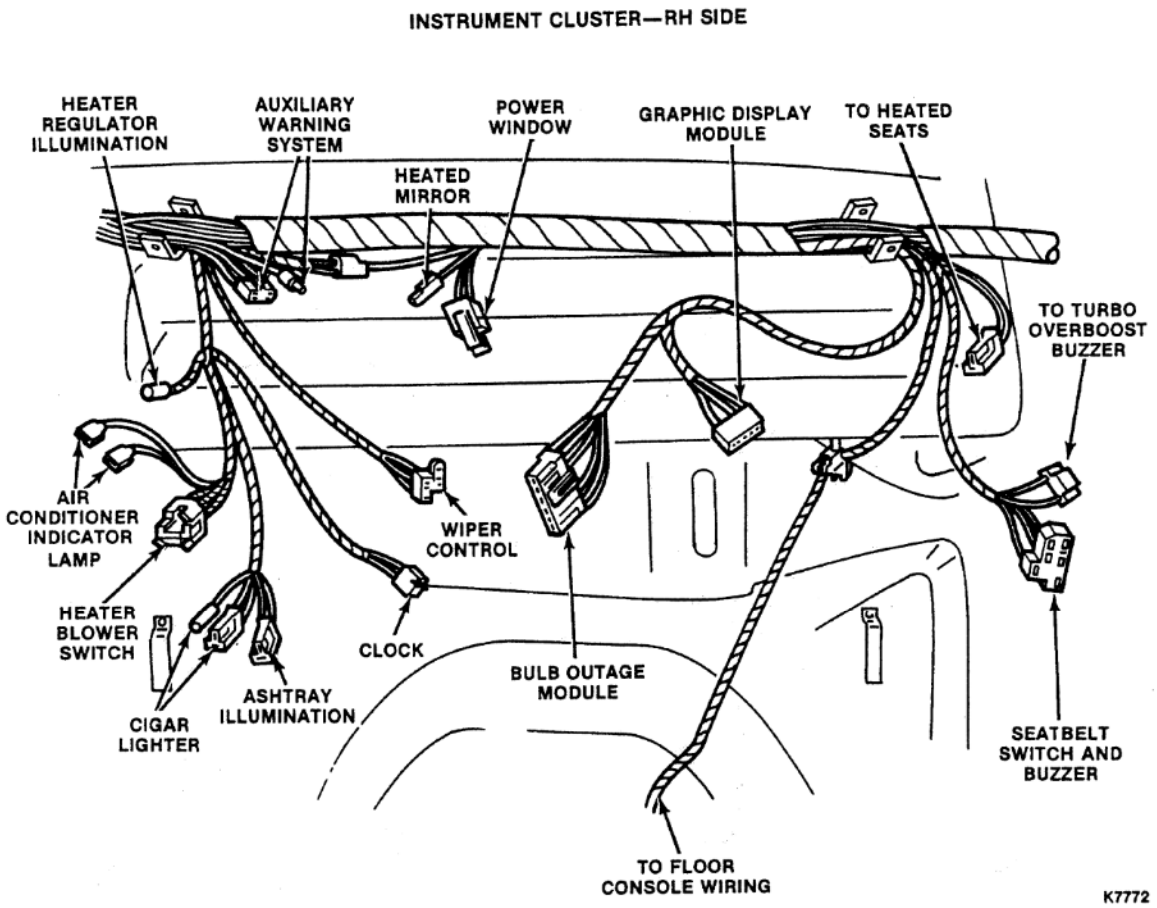
4. Remove the instrument cluster. Refer to Section 33-50. Disconnect all connectors between the main wiring harness assembly and the body wiring assemblies.

INSTRUMENT CLUSTER WIRING



REMOVAL AND INSTALLATION (Continued)

BASE HARNESS WIRING HARNESS (Continued)

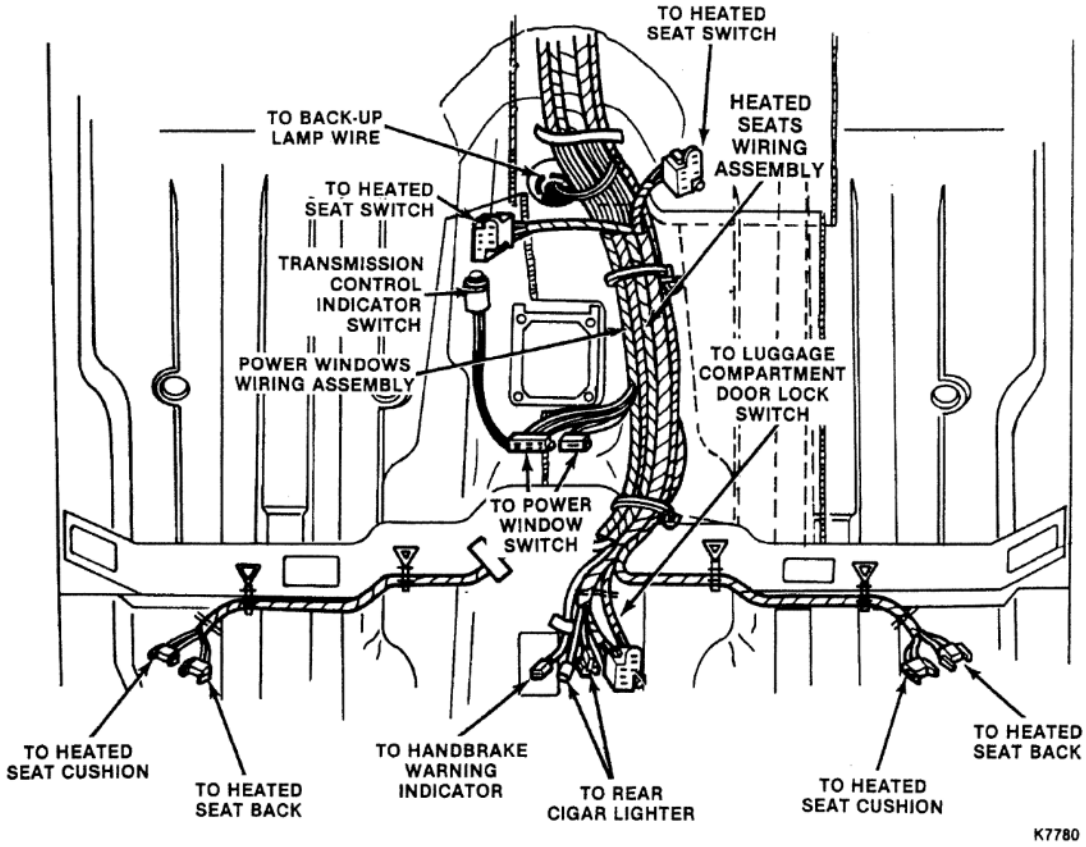


REMOVAL AND INSTALLATION (Continued)

BASE HARNESS WIRING HARNESS (Continued)

5. Remove the instrument panel pad per Section 45-61.
6. Remove fuse panel from connection.
7. From inside the vehicle, pull that portion of the main wiring harness assembly that is in the engine compartment through the dash panel into the passenger compartment.
8. Remove the floor console. Refer to Section 45-31.Disconnect the main harness wiring from the transmission.

FLOOR CLUSTER WIRING



REMOVAL AND INSTALLATION (Continued)

BASE HARNESS WIRING HARNESS (Continued)

9. Remove the front and rear seats. Refer to Section 41-14 and 41-01.
10. Remove the door sills.
11. Remove the rear parcel shelf bracket.
12. Remove the carpeting. Refer to Section 45-26.
13. Disconnect all the main wiring harness assembly connectors, retainers and locators and remove the main wiring assembly from the vehicle.

Installation

1. Compare the new harness with the old harness. Transfer the hazard flasher, turn signal flasher and all fuses to the new harness fuse panel. Transfer bulbs to the new harness instrument panel sockets.
2. Reverse the removal procedure to install the new wiring assembly.
3. Check the vehicle electrical system for proper operation.

SECTION 34-20 WIRING HARNESS—ENGINE

CONTENTS

Page

DESCRIPTION 1

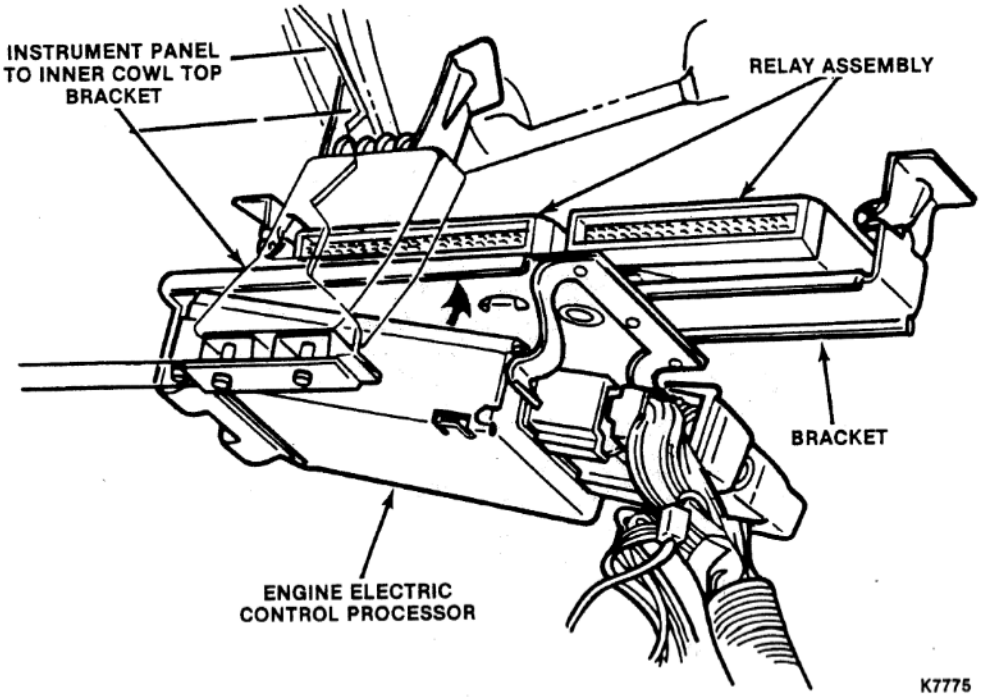
REMOVAL AND INSTALLATION 1

DESCRIPTION

The engine wiring harness is connected to various points on the left-hand fender apron and routed along the dash panel to the right-hand fender apron. It is also connected to several points on the engine and to the Electronic Engine Control (EEC) module on the right-hand cowl side, inside the passenger compartment.

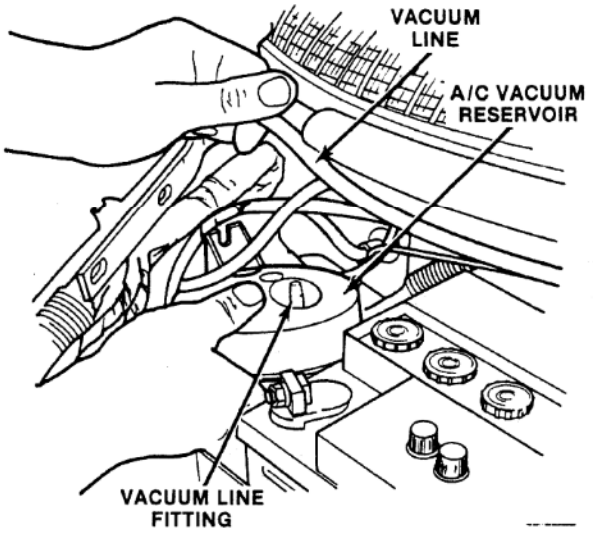
REMOVAL AND INSTALLATION

1. Disconnect the ground cable at the battery.
2. Remove the passenger side cowl trim panel. Refer to Section 45-03.
3. Remove the passenger side instrument panel. Refer to Section 45-61.
4. Disconnect the EEC power relay and the EEC module.



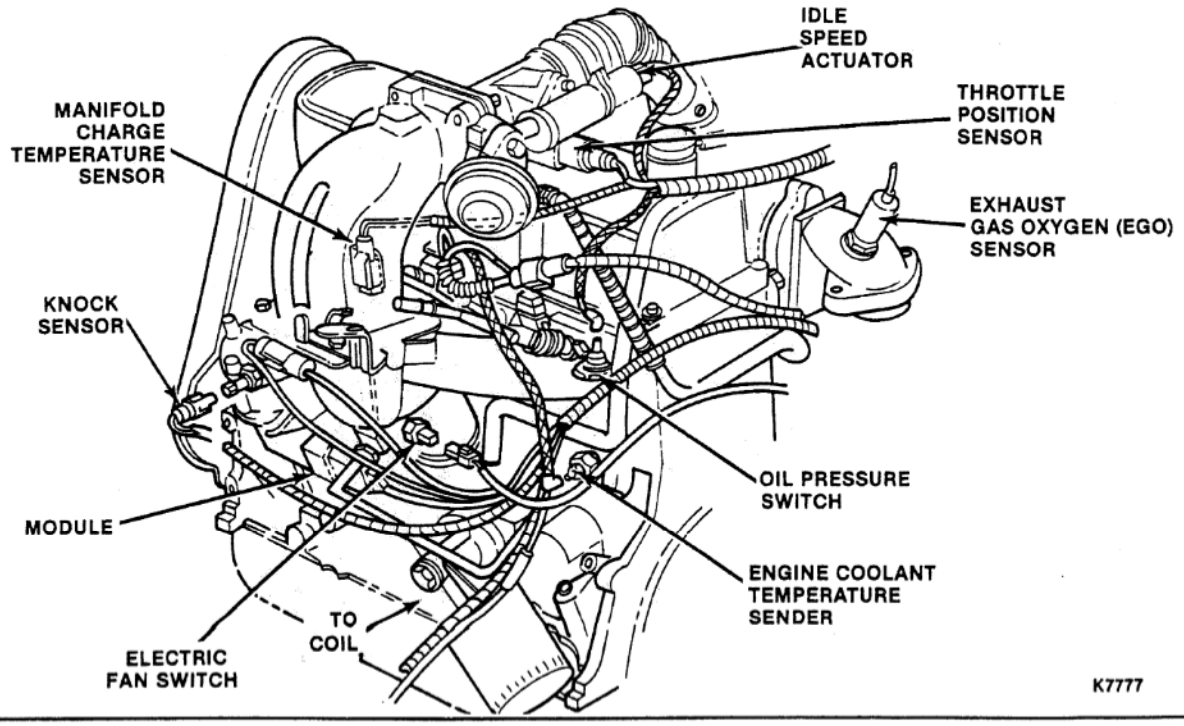
REMOVAL AND INSTALLATION (Continued)

5. Remove the A/C vacuum reservoir.

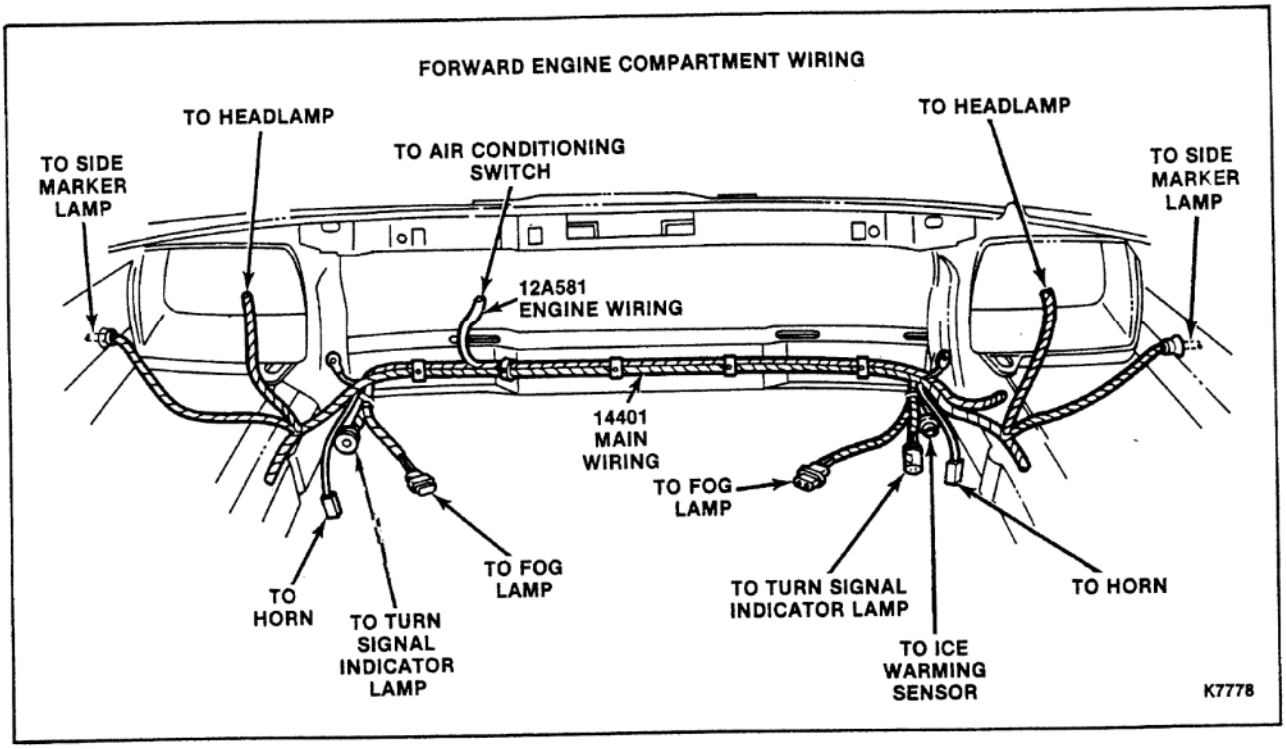


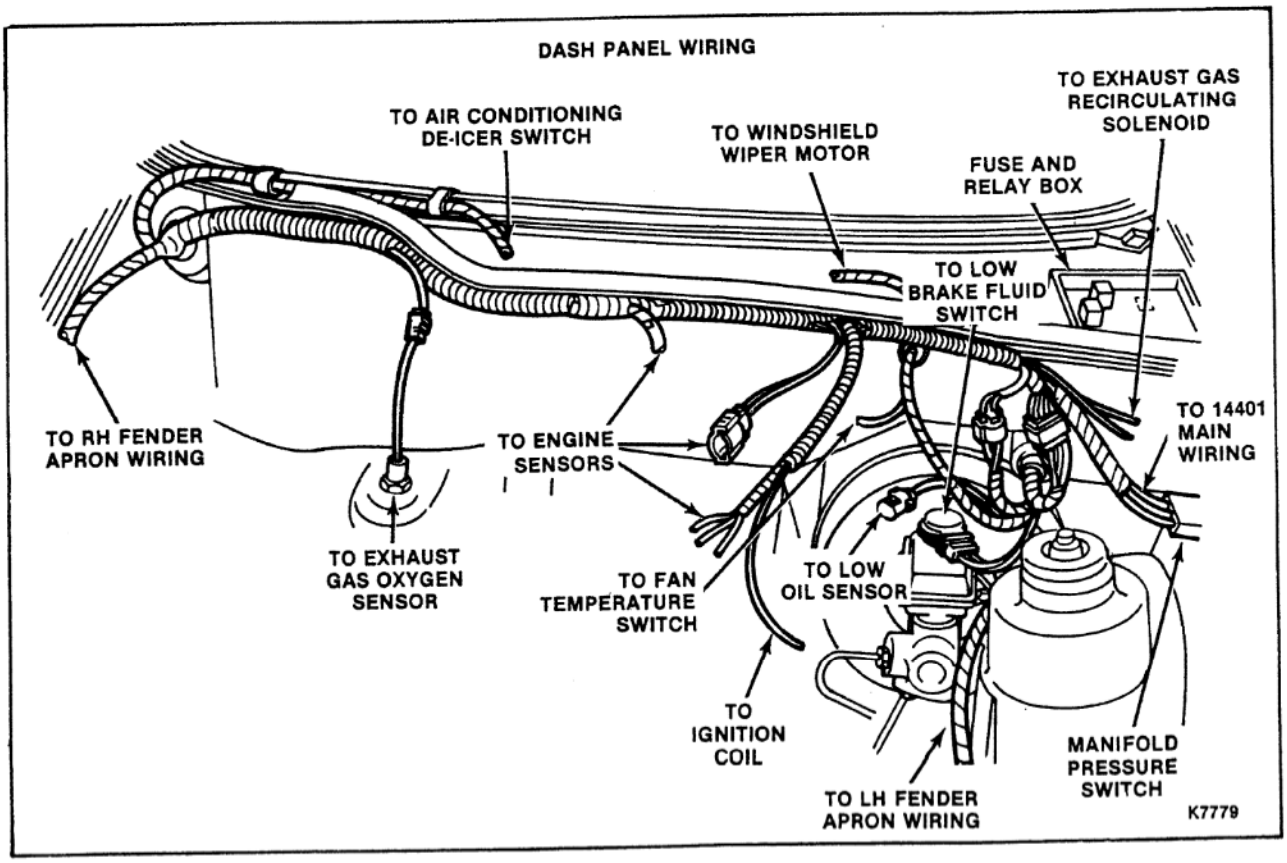
6. Remove the grille opening panel. Refer to Section 47-10.
7. Disconnect all electrical connectors and retainers to the engine wiring harness as illustrated on the next few pages.
8. To install, reverse steps 1 through 7.

ENGINE WIRING—LH SIDE



REMOVAL AND INSTALLATION (Continued)





SECTION 34-30 Fuses, Relays and Warning Systems

SUBJECT	PAGE
DESCRIPTION	
Fuse Panel	34-30-2
Warning Buzzer Locations	34-30-1
DIAGNOSIS AND TESTING	
Fuse Link Continuity Test	34-30-4
REMOVAL AND INSTALLATION	
Fuse Link Replacement	34-30-4
Fuses and Relays	34-30-4
SERVICE PROCEDURES	
Fuse Link	34-30-5

DESCRIPTION

Warning Buzzer Locations

Seat Belt Warning

The seat belt warning buzzer is located behind the right-hand side of the instrument panel. With the ignition switch in ON, current flows through fuse 9 and the "Fasten Belts" indicator in the auxiliary warning system for 4 to 8 seconds, whether belts are buckled or not. The buzzer will sound during this time only if the driver's belt is not buckled.

Key/Lights On Warning Buzzer

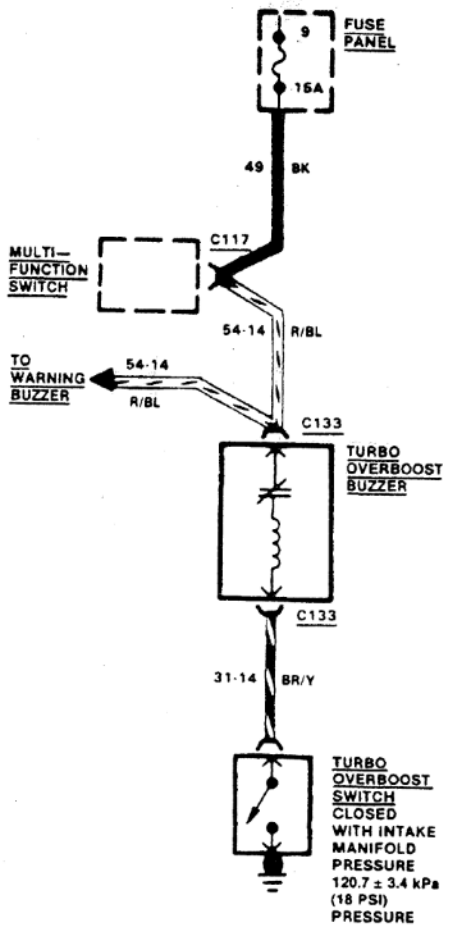
The key buzzer (if equipped) will sound when the ignition key is in the "OFF", "ACC" or "RUN" positions and the driver's door is opened.

The same buzzer will sound to indicate that the lights have been left on if the key is removed, the light switch is in positions "I" or "II" and the driver's door is opened.

This buzzer is located with the seat belt buzzer behind the right-hand side of the instrument panel.

Turbo Boost/Vacuum Gauge

The turbo overboost gauge indicates positive boost during turbocharger operation and vacuum when the turbocharger is not in operation. If the turbocharger generates an "overboost," an overboost buzzer will sound. The turbo overboost buzzer is located behind the right-hand side of the instrument panel. This buzzer is activated when manifold pressure exceeds about 120.7 ± 3.4 kPa (18 psi).

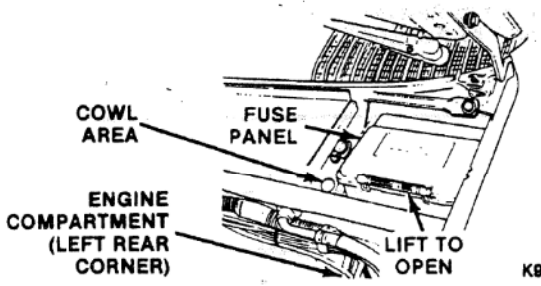


K7768

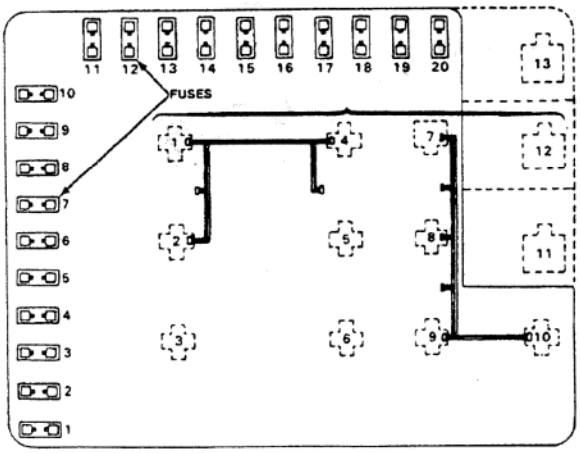
DESCRIPTION (Continued)

Fuse Panel

The fuse panel is located in the cowl area near the left rear corner of the engine compartment.



The location of each fuse and relay is shown in the schematic below.



K10112

The rating of each fuse and relay is shown in one of the following charts.

EARLY 1985

POSITION/ RATING (AMPS)	COLOR	ISO SYMBOL	CIRCUITS PROTECTED
1 / 30	Lt. Green		Power Windows, Power Door Locks, Speed Control
2 / 30	Lt. Green		Rear Window Defroster
3 / 30	Lt. Green		Windshield Wipers
4 / 30	Lt. Green		Heater Blower, Rear Wipers, Windshield Washers
5 / 30	Lt. Green		Backup Lamps
6 / 15	Lt. Blue		Horn
7 / 15	Lt. Blue		Stop Lamps
8 / 10	Red		Clock, Auxiliary Warning Module, Instrument Cluster, Interior Lamp Delay, Windshield Wipers, Bulb Outage Module
9 / 15	Lt. Blue		Turn Signals, Hazard Flashers
10/ 15	Lt. Blue		Fog Lamps
11/ 30	Lt. Green		A/C Cond. Fan, Heated Seats
12/ 25	Natural		Courtesy Lamps, Cigar Lighters, Visor Mirror, Tripminder
13/ 10	Red		Hazard Flashers, Horn
14/ 10	Red		Headlamps
15/ 10	Red		Headlamps, Instrument Cluster Illumination
16/ 10	Red		Bulb Outage Module
17/ 10	Red		Bulb Outage Module, Fog Lamps
18/ 10	Red		Marker Lamps, Engine Compartment Lamp, License Lamps, Bulb Outage Module
19/ 10	Red		I/P Illumination Control, Ash Tray Lamps, Marker Lamps, Turn Signal Lamps
20/ 25	Natural		Engine Cooling Fan

NOTE—Fuel pump fuse located under fuse panel (in wiring).

ISO SYMBOL	RELAY POSITION	CIRCUIT PROTECTED
	1	A/C Temp. Switch
	2	Horn
	3	A/C Clutch W.O.T.
	4	Fuel Pump
#0	5	Fog Lamps
—	6	(Blank)
	7	Interval Windshield Wipers
	8	Stop Lamp
	9	Seat Belt Reminder
	10	Ignition Switch
	11	Rear Wipers
	12	Interior Lamp Delay
	13	Heated Backlite

Relays Under the Instrument Panel
- Bulb test control
- Warning lights
- Central door locking
- EEC power
- A/C fan
- Temperature switch
- Engine fan
- Fuel pump

Relays Mounted on Brake Pedal Support Bracket
- Indicates hazard flasher warning lights
- Heated front seats
- Electrically operated antenna
- Electrically operated windows

K9535-A

DESCRIPTION

FUSE PANEL (Continued)

RUNNING CHANGE 1985

POSITION/ RATING (AMPS)	COLOR	ISO SYMBOL	CIRCUITS PROTECTED
1 / 30	Lt. Green		Power Windows, Power Door Locks, Speed Control
2 / 30	Lt. Green		Rear Window Defroster
3 / 30	Lt. Green		Windshield Wipers
4 / 30	Lt. Green		Heater Blower, Rear Wipers, Windshield Washers
5 / 10	Red		Backup Lamps
6 / 15	Lt. Blue		Horn
7 / 15	Lt. Blue		Stop Lamps
8 / 10	Red		Clock, Auxiliary Warning Module, Instrument Cluster, Interior Lamp Delay, Windshield Wipers, Bulb Outage Module
9 / 15	Lt. Blue		Turn Signals, Hazard Flashers
10/ 15	Lt. Blue		Fog Lamps
11/ 30	Lt. Green		A/C Cond. Fan, Heated Seats
12/ 25	Natural		Courtesy Lamps, Cigar Lighters, Visor Mirror, Tripminder
13/ 10	Red		Hazard Flashers, Horn
14/ 10	Red		Headlamps
15/ 10	Red		Headlamps, Instrument Cluster Illumination
16/ 10	Red		Bulb Outage Module
17/ 10	Red		Bulb Outage Module, Fog Lamps
18/ 10	Red		Marker Lamps, Engine Compartment Lamp, License Lamps, Bulb Outage Module
19/ 10	Red		I/P Illumination Control, Ash Tray Lamps, Marker Lamps, Turn Signal Lamps
20/ 25	Lt. Blue		Fuel Pump.

ISO SYMBOL	RELAY POSITION	CIRCUIT PROTECTED
	1	A/C Temp. Switch
	2	Horn
	3	A/C Condenser Fan
	4	Fuel Pump
	5	Fog Lamps
—	6	(Blank)
	7	Interval Windshield Wipers
	8	Engine Cooling Fan
	9	Seat Belt Reminder
	10	Ignition Switch
	11	Rear Wipers
	12	Interior Lamp Delay
	13	Heated Backlite

Relays Under the Instrument Panel
- Bulb test control
- Warning lights
- Central door locking
- EEC power
- A/C fan
- Temperature switch
- Engine fan
- Fuel pump

Relays Mounted on Brake Pedal Support Bracket
- Indicates hazard flasher warning lights
- Heated front seats
- Electrically operated antenna
- Electrically operated windows

K9536-A

1986

POSITION/ RATING (AMPS)	COLOR	ISO SYMBOL	CIRCUITS PROTECTED
1 / 30	Lt. Green		Power Windows, Power Door Locks, Speed Control
2 / 30	Lt. Green		Rear Window Defroster
3 / 30	Lt. Green		Windshield Wipers
4 / 30	Lt. Green		Heater Blower, Rear Wipers, Windshield Washers, A/C Switch, Engine and A/C Fan Relay
5 / 10	Red		Backup Lamps, W.O.T. Relay
6 / 15	Lt. Blue		Horn
7 / 15	Lt. Blue		Stop Lamps
8 / 10	Red		Clock, Auxiliary Warning Module, Instrument Cluster, Interior Lamp Delay, Windshield Wipers, Bulb Outage Module
9 / 15	Lt. Blue		Turn Signals, Hazard Flashers
10/ 15	Lt. Blue		Fog Lamps
11/ 30	Lt. Green		A/C Temp. Fan, Heated Seats
12/ 25	Natural		Courtesy Lamps, Cigar Lighters, Visor Mirror, Tripminder
13/ 10	Red		Hazard Flashers, Horn
14/ 10	Red		Headlamps
15/ 10	Red		Headlamps, Instrument Cluster Illumination
16/ 10	Red		Bulb Outage Module
17/ 10	Red		Bulb Outage Module, Fog Lamps
18/ 10	Red		Marker Lamps, Engine Compartment Lamp, License Lamps, Bulb Outage Module
19/ 10	Red		I/P Illumination Control, Ashtray Lamps, Marker Lamps, Turn Signal Lamps
20/ 15	Lt. Blue		Fuel Pump

ISO SYMBOL	RELAY POSITION	CIRCUIT PROTECTED
	1	A/C Temp. Switch
	2	Horn
—	3	W.O.T. Relay
	4	Fuel Pump
	5	Fog Lamps
—	6	(Blank)
	7	Interval Windshield Wipers
—	8	Stop Lamp
	9	Seat Belt Reminder
	10	Ignition Switch
	11	Rear Wipers
	12	Interior Lamp Delay
	13	Heated Backlite

Relays Under the Instrument Panel
- Bulb test control
- Warning lights
- Central door locking
- EEC power

Relays Mounted on Brake Pedal Support Bracket
- Turn signal/hazard flasher
- Heated front seats
- Electrically operated antenna

K9537-A

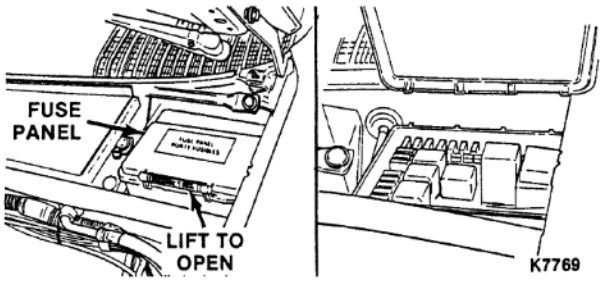
REMOVAL AND INSTALLATION

FUSES AND RELAYS

1. Open the fuse box by pressing the retaining handle inward and removing the cover.
2. With the panel exposed, locate the blown fuse and remove it using needle nose pliers.
3. Replace the blown fuse or relay with the same approved amp rating for that particular circuit. To install the new fuse or relay, push straight in until the fuse or relay seats itself fully in the cavity. A blown fuse will be recognized by a break in its wire.

CAUTION: Always replace a blown fuse with the same rating as specified. Never replace with a higher amperage rating because severe wiring damage and possibly fire can result.





FUSE LINK REPLACEMENT

1. Procure the proper service fuse link. Make sure that the replacement fuse link is a duplicate of the one removed with respect to the gauge, length and insulation. Do not substitute any other type of gauge or wire. When the terminal is not required, cut off the fuse link as close to the terminal as possible and strip approximately 3 mm (1/8 in.) of insulation from the cut end.
2. Disconnect the battery ground cable.
3. Disconnect the fuse link and/or fuse link eyelet terminal from the battery terminal of the starter relay.

DIAGNOSIS AND TESTING

FUSE LINK CONTINUITY TEST

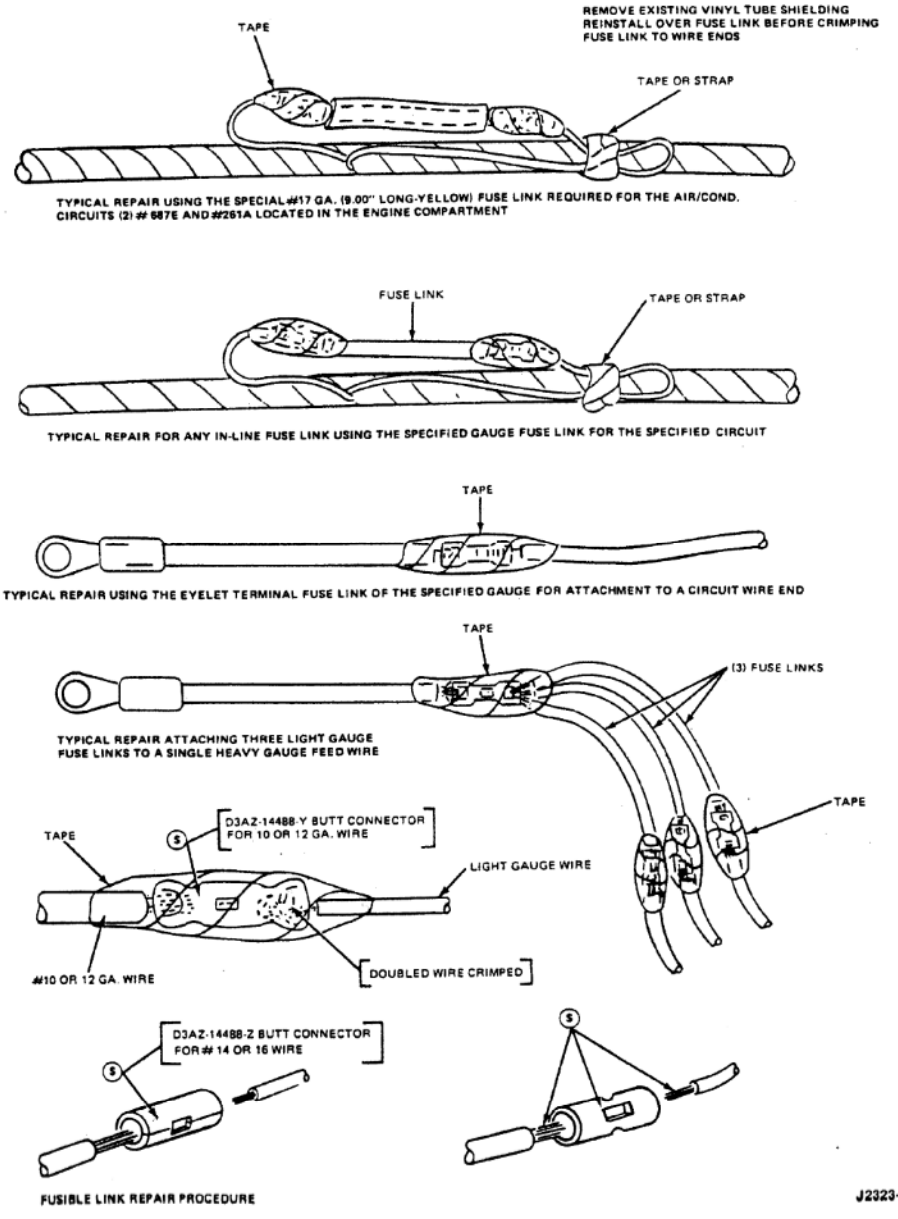
Make certain that the battery is at full charge, then turn on the headlamps or any accessory. If the headlamps or accessory do not operate, check the fuse link.

To test the fuse link that protects the alternator, make certain that the battery is at full charge, then check with a voltmeter for the same voltage reading A+ at the BAT terminal of the alternator. No voltage indicates that the fuse link has an open and must be repaired.

SERVICE PROCEDURES

FUSE LINK

1. Determine which circuit is damaged, its location and the cause of the open fuse link. If the damaged fuse link is one of three fed by a common number 10 or 12 gauge feed wire, determine the specific affected circuit.
2. Disconnect the negative battery cable.
3. Cut the damaged fuse link from the wiring harness and discard it. If the fuse link is one of three circuits fed by a single feed wire, cut it out of the harness at each splice end and discard it.
4. Identify and procure the proper fuse link and butt connectors for attaching the fuse link to the harness.



SERVICE PROCEDURES (Continued)

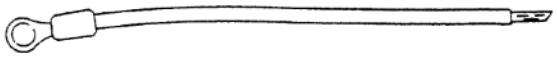
FUSE LINK (Continued)

WIRING ASSEMBLY — FUSE LINK
(WITH INSULATION STRIPPED BOTH ENDS)



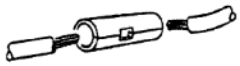
D3AZ—14A526-H	#14 GA. WIRE — 9.00" ± .50 LENGTH (GREEN INSULATION)
D3AZ—14A526-J	#16 GA. WIRE — 9.00" ± .50 LENGTH (ORANGE INSULATION) AS REQ'D.
D3AZ—14A526-K	#17 GA. WIRE — 9.00" ± .50 LENGTH (YELLOW INSULATION) AS REQ'D. (SPECIAL USED WITH AIR CONDITIONING SYSTEM)
D3AZ—14A526-L	#18 GA. WIRE — 9.00" ± .50 LENGTH (RED INSULATION) AS REQ'D.
D3AZ—14A526-M	#20 GA. WIRE — 9.00" ± .50 LENGTH (BLUE INSULATION) AS REQ'D.

WIRING ASSEMBLY — FUSE LINK
(WITH EYELET TERMINAL AND ONE END STRIPPED)



D3AZ—14A526-D	#14 GA. WIRE — 9.00" ± .50 LENGTH (GREEN INSULATION) AS REQ'D.
D3AZ—14A526-E	#16 GA. WIRE — 9.00" ± .50 LENGTH (ORANGE INSULATION) AS REQ'D.
D3AZ—14A526-F	#18 GA. WIRE — 9.00" ± .50 LENGTH (RED INSULATION) AS REQ'D.
D3AZ—14A526-G	#20 GA. WIRE — 9.00" ± .50 LENGTH (BLUE INSULATION) AS REQ'D.

BUTT CONNECTOR — WIRING SPLICE



D3AZ—14488-Y	FOR #10 AND 12 GA. WIRE (LOAD CIRCUIT) AS REQ'D.
D3AZ—14488-Z	FOR #14 AND 16 GA. WIRE (LOAD CIRCUIT) AS REQ'D.

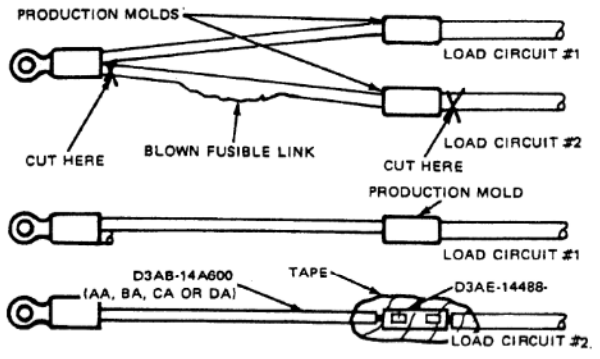
J2324-A

5. To service two-link groups when only one link has blown:

   a. Cut out blown fusable link (two places).

   b. Position correct eyelet type service fusible link and crimp connect to wire ends.

   c. Solder serviced joint and insulate with tape.



J2204-A

SERVICE PROCEDURES (Continued)

FUSE LINK (Continued)

6. To service any fuse link in a three link group with one lead:
   a. After cutting the open link out of the harness, cut each of the remaining undamaged fuse links close to the feed wire weld.
   b. Strip approximately 12.70 mm (1/2 in.) of insulation from the detached ends of the two good fuse links. Then insert the two wire ends into one end of a D3AZ-1488-Y or Z butt connector and carefully push one stripped end of the replaceable fuse link into the same end of the butt connector and crimp all three together firmly. Care must be taken when fitting the three fuse links into the butt connector as the internal diameter is a snug fit for three wires. Make sure to use the proper crimping tool as pliers, side cutters, etc. will not apply the proper crimp to retain the wires.
   c. After crimping the butt connector to the three fuse links, cut the weld portion from the feed wire and strip approximately 12.70 mm (1/2 in.) of insulation from the cut end. Insert the stripped end of the fuse link into the open end of the butt connector and crimp very firmly.
   d. To attach the remaining end of the replacement fuse link, strip approximately 12.70 mm (1/2 in.) of insulation from the wire end of the circuit from which the blown fuse link was removed, and firmly crimp a D3AZ-14488-0Y or Z butt connector to the stripped wire. Then, insert the end of the replacement link into the other end of the butt connector and crimp firmly.
   e. Using rosin core solder with a consistency of 60% tin, 40% lead, solder the connectors and the wires at the services and insulate with electrical tape.
7. To replace any fuse link on a single circuit in a harness, cut out the damaged portion, strip approximately 12.70 mm (1/2 in.) of insulation from the two wire ends, and attach the appropriate replacement fuse link to the stripped wire ends with two proper size butt connectors. Solder the connectors and wires and insulate with tape.
8. To service any fuse link which has an eyelet terminal on one end such as the charging circuit, cut off the open fuse link behind the weld, strip approximately 12.70 mm (1/2 in.) of insulation from the wire and attach the appropriate new eyelet fuse link using a butt connector. Solder the connectors and wires and insulate with tape.
9. Connect the negative battery cable to the battery and test the system for proper operation. DO NOT MISTAKE A RESISTOR WIRE FOR A FUSE LINK. The resistor wire is generally longer and has print stating, "Resistor—do not cut or splice."

   When attaching a single number 16, 17, 18 or 20-gauge fuse link to a heavy gauge wire, always double the stripped wire end of the fuse link before inserting and crimping it into the butt connector for positive wire retention.

AUXILIARY EQUIPMENT

GROUP 35

TITLE SECTION	PAGE NO.
RADIO AND STEREO TAPE PLAYER—ELECTRONIC 35-03	
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REMOVAL AND INSTALLATION	
Radio Chassis Receiver	2
Radio Chassis Fuse	3
CLEANING	3
POWER ANTENNA AND SPEAKERS 35-21	
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DIAGNOSTIC CHART	2
ELECTRICAL SCHEMATIC	5
REMOVAL AND INSTALLATION	
Power Antenna	6
Radio Speaker (Left-Hand Lower-Instrument—Panel Mounted)	10
Radio Speaker (Passenger Side Lower-Instrument-Panel Mounted)	11
Radio Speaker(Rear-Parcel—Shelf Mounted)	11
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ASH RECEPTACLES AND CIGAR LIGHTER 35-40	
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Ashtray Bulb	2
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WINDSHIELD WIPERS 35-60	
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TESTING	
Wiper Motor Current Draw	2
DIAGNOSIS	2
ADJUSTMENTS	
Arm and Blade Assembly	3
REMOVAL AND INSTALLATION	
Wiper Motor	3
Wiper Switch	4
Windshield Wiper Blade Replacement	5
Windshield Wiper Linkage	5
Liftgate Wiper Motor	7
WINDSHIELD WASHERS 35-70	
DESCRIPTION	1
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Windshield Washer Reservoir and Bracket	4
Liftgate Washer Reservoir	5
Windshield Washer Nozzle	6
Liftgate Nozzle	6
HORN 35-80	
DESCRIPTION	2
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Circuit Check	2
REMOVAL AND INSTALLATION	
Horn and Bracket	2
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GROUP

AUXILIARY EQUIPMENT 35

(17000 & 18000)

SECTION TITLE	PAGE
ASH RECEPTACLES AND CIGAR LIGHTER	35-40-1
HORN	35-80-1
POWER ANTENNA AND SPEAKERS	35-21-1
RADIO AND STEREO TAPE PLAYER—ELECTRONIC	35-03-1
WINDSHIELD WASHERS	35-70-1
WINDSHIELD WIPERS	35-60-1

SECTION 35-03 Radio and Stereo Tape Player—Electronic

SUBJECT	PAGE
CLEANING	35-03-4
DECRIPTION	35-03-1
REMOVAL AND INSTALLATION	
Radio Chassis Fuse	35-03-3
REMOVAL AND INSTALLATION (Cont'd.)	
Radio Chassis Receiver	35-03-3

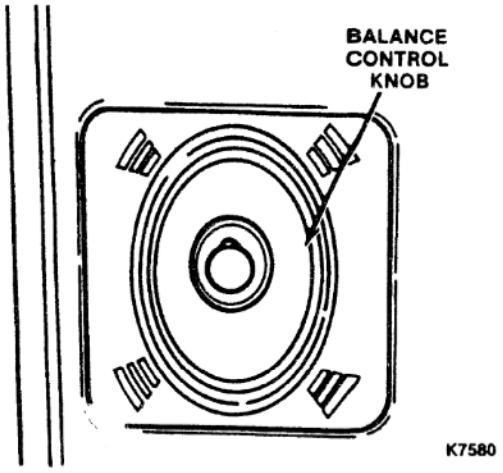
DECRIPTION

The electronic AM/FM stereo seek/scan radio/cassette is located in the lower center console of the instrument panel. All wiring including the antenna cable is fed into the rear face of the receiver from behind the lower console. The receiver is held to the console by a spring and locating clips on each side.

NOTE: To remove the radio, it is essential to use the special tool T85M-19061-A. Refer to radio chassis removal.

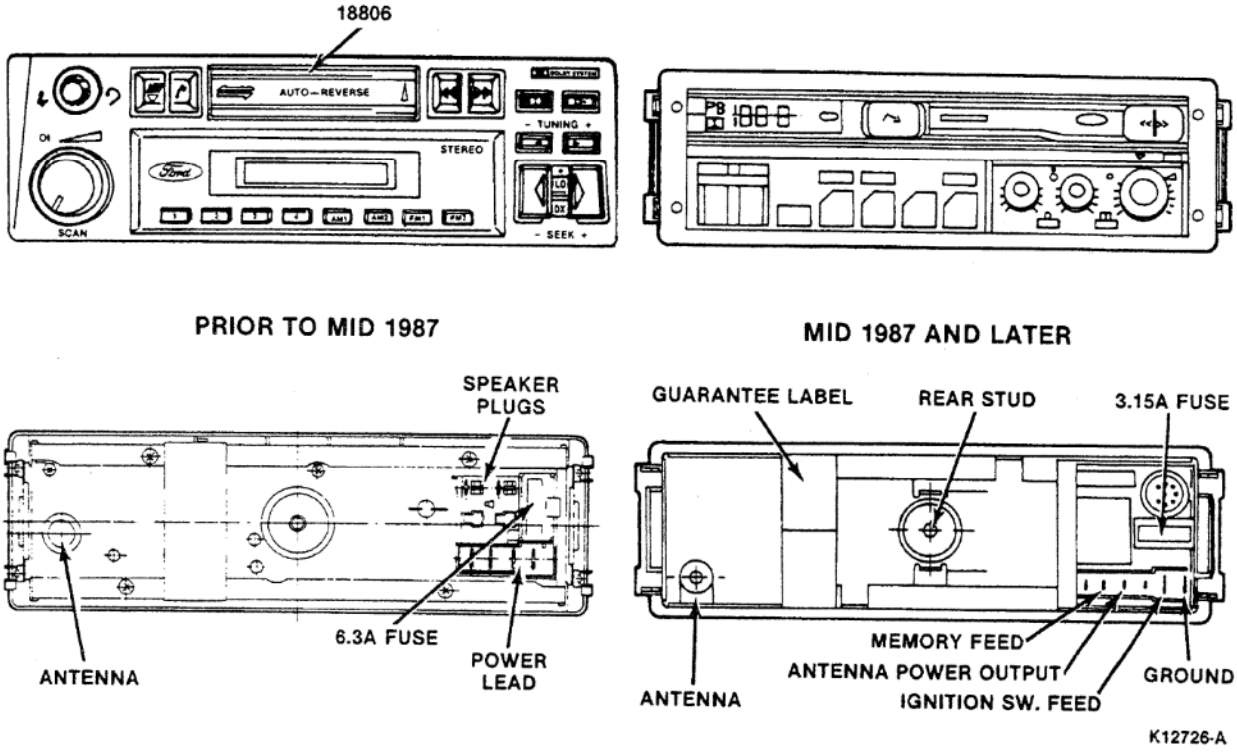
A plastic guide is fitted to the rear of the receiver that slides onto a metal slotted rail to create a dovetail joint. This provides for a firm seating at the rear of the receiver.

The speaker balance control is provided by a joy stick-type control knob fitted in the lower center console. The console knob can move in both vertical and horizontal planes or any combination thereof. The balance control, therefore, can single out one of any number of speakers enabling a side-to-side or front-to-rear combination.



DECRIPTION (Continued)

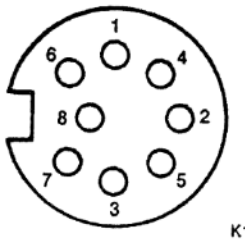
Two radios are available as shown. The later unit was introduced in mid 1987. Both radios are replaced in the same manner. Both radios are protected by a fuse located in the back of the radio. If the radio is inoperative, and the antenna does not rise, check this fuse prior to sending the radio out for service.



DECRIPTION (Continued)

For Mid 1987 and later radio units the pin connections are as shown below.

PIN	USED FOR
1	REMOTE SEARCH (UP)
2	GROUND (AUDIO SIGNAL)
3	LEFT SIGNAL OUTPUT
4	—
5	RIGHT SIGNAL OUTPUT
6	REMOTE SEARCH (DOWN)
7	ILLUMINATION
8	RADIO SENSE



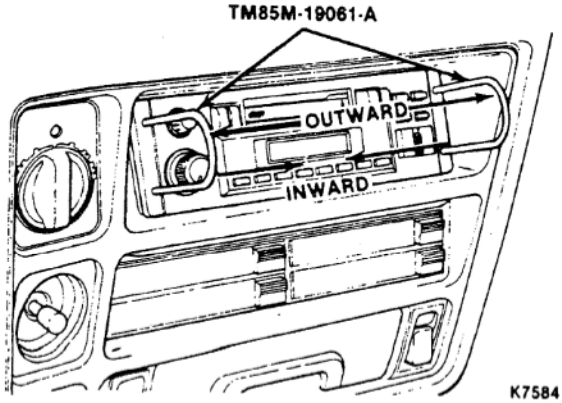
K12727-A

REMOVAL AND INSTALLATION

Radio Chassis Receiver

Removal

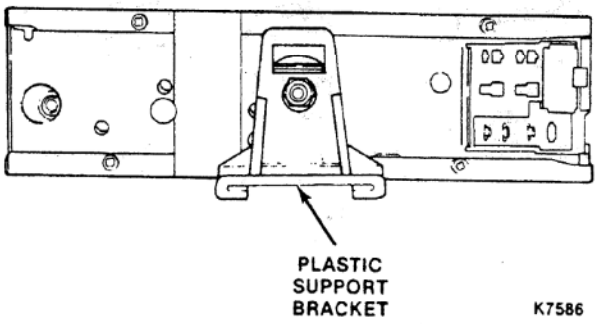
1. Disconnect the ground cable from the battery.
2. Insert the two radio removing tools (T85M-19061-A), one per each side of the radio, into the access holes until a click is heard.
3. Apply an outward side pressure to release the locking tangs and slide the radio from the dash.



K7584

4. Disconnect the antenna, speaker, ground, and power leads from the radio.
5. Disengage the special tool by depressing the locking tangs on the side of the radio while applying slight inward pressure on the tool. Pull tool out of access holes.

6. Remove the plastic support bracket and locating plate from the rear of the receiver.



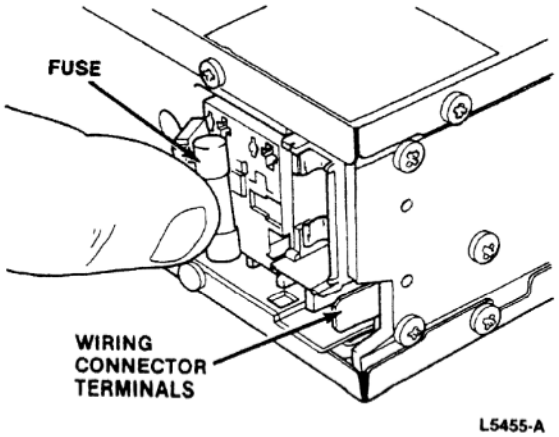
K7586

Installation

1. Connect the power supply, speaker plugs, and antenna cable to the rear of the receiver.
2. Install the locating plate and plastic support bracket to the rear of the receiver and slide the receiver into the aperture until the retaining tangs lock.
3. Reconnect the battery ground cable.

Radio Chassis Fuse

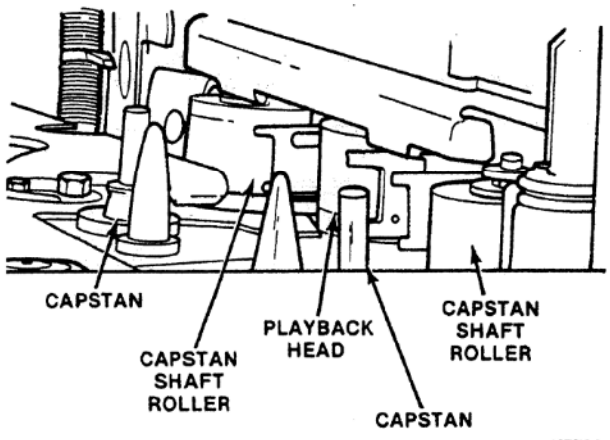
The radio chassis fuse is in the back of the radio. To check the fuse, the radio must first be removed. The radio removal procedure is included in this Section. The fuse is located under a small snap-in cover located just above the radio wiring connector terminals.



L5455-A

CLEANING

Over a period of time, the playback head and the capstan shaft roller in the tape player may gather an oxide residue from the tape coating as the tape passes over the head. This accumulation can cause weak or wavering sound, and should be removed periodically using a commercially available cleaning system.



SECTION 35-21 Power Antenna and Speakers

SUBJECT	PAGE
DESCRIPTION	
Antenna (Some 1987 Models)	35-21-2
Antenna Mast	35-21-1
Antenna Relay	35-21-2
Power Antenna Assembly	35-21-1
Radio Speakers	35-21-2
Signal Amplifier/Filter (Some 1987 Models)	35-21-2
DIAGNOSTIC CHART	
Introduction	35-21-3
ELECTRICAL SCHEMATIC	35-21-6
REMOVAL AND INSTALLATION	
Power Antenna Assembly	35-21-7
Radio Speaker (Left-Hand Lower-Instrument-Panel Mounted)	35-21-10
Radio Speaker (Passenger Side Lower-Instrument-Panel Mounted)	35-21-10
Radio Speaker (Rear-Parcel-Shelf Mounted)	35-21-11
Speaker Balance Control Assembly	35-21-11

DESCRIPTION

Power Antenna Assembly

The power antenna assembly is mounted in the driver's side rear quarter panel. With the ignition switch in the ACC or RUN position, and the radio turned on, battery voltage is sent from the radio to close an electromagnetic switch inside the power antenna assembly. This switch relays battery voltage to the power antenna motor, which in turn extends the antenna mast.

Turning the ignition and/or radio off will open the circuit to the electromagnetic switch. The switch will then relay battery voltage through an alternate circuit to reverse the polarity of the antenna motor, which in turn retracts the antenna mast. When the antenna reaches the end of its travel in either direction, limit switches will open the feed circuit to the antenna motor, to prevent continued operation.

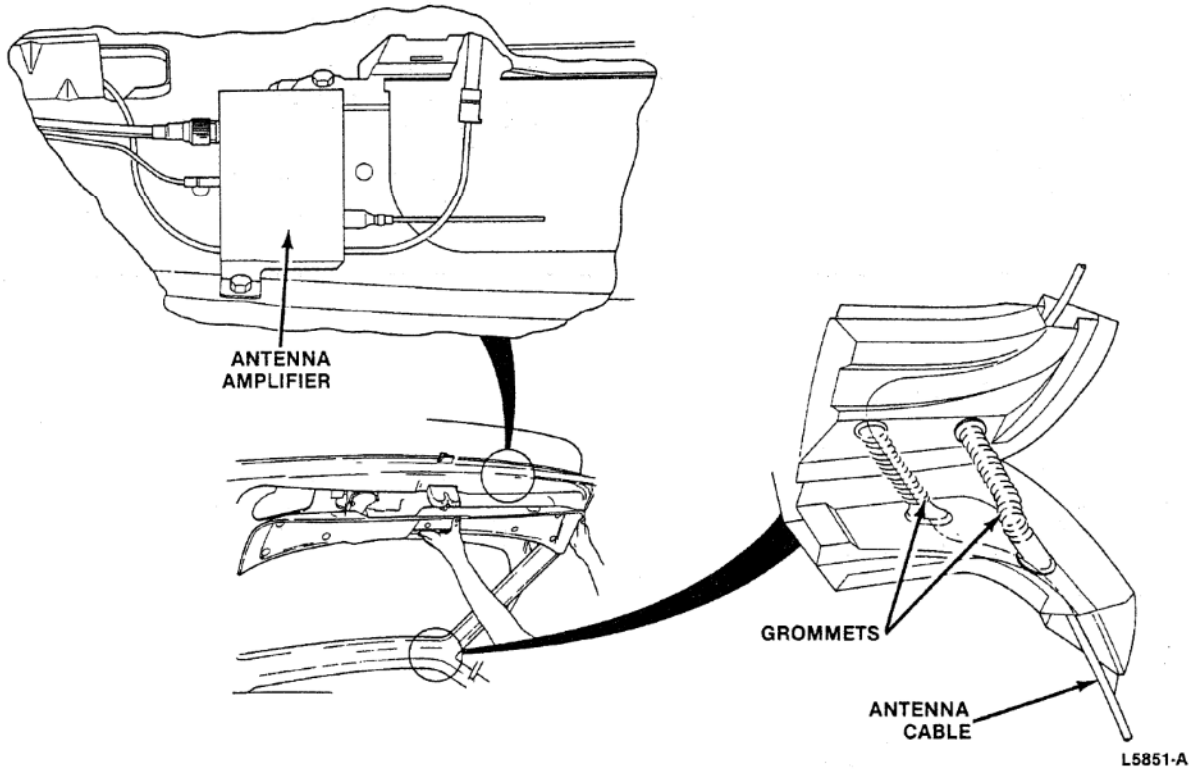
Antenna Mast

The antenna mast consists of five telescopic tube sections and is serviced only as part of the power antenna assembly.

DESCRIPTION (Continued)

Signal Amplifier/Filter (Some 1987 Models)

A signal amplifier/filter is attached to the liftgate lower panel. This amplifies and filters the signal received from the grid antenna for use by the radio.



Antenna Relay

The antenna relay is mounted on the steering column brace behind the instrument cluster, and will open the feed circuit to the antenna motor whenever the ignition switch is in the start position.

Antenna (Some 1987 Models)

The radio antenna is an integral part of the rear window defroster grid.

Radio Speakers

Two speakers are mounted in the upper rear quarter trim panels and two more are mounted in the lower instrument panel.

SECTION 35-21 POWER ANTENNA AND SPEAKERS

CONTENTS

Page

DESCRIPTION 1

DIAGNOSIS AND TESTING 1

REMOVAL AND INSTALLATION

Power Antenna 2
Radio Antenna Mast 3
Radio Speaker (Left-Hand Lower-Instrument—Panel Mounted) 4
Radio Speaker (Passenger Side Lower-Instrument-Panel Mounted) 5
Radio Speaker (Rear-Parcel—Shelf Mounted 5
Speaker Balance Control Assembly 6

DESCRIPTION

The power antenna is mounted on the driver's side rear quarter panel. The antenna is operated when the radio receiver is switched on and the ignition is in either the ACC or RUN position. The antenna will retract when either the receiver and/or ignition are turned off. The antenna mast consists of five telescopic tube sections serviced as an assembly.

NEVER PUSH THE MAST DOWN MANUALLY AS DAMAGE TO THE DRIVE MECHANISM WILL RESULT.

Two speakers are mounted in the rear parcel shelf support and two are mounted in the lower instrument panel.

DIAGNOSIS AND TESTING

- Make sure the power antenna is fully extended.
- If antenna will not raise or lower, check for battery voltage at the antenna motor connector. If battery voltage is not present on one or both of the connectors, check fuse and antenna switch wiring. If battery voltage is present at both connectors, replace the antenna motor assembly.
- If AM reception is extremely poor and FM reception "spits" or loses stations, make sure that the antenna and antenna connectors are properly mated. If the antenna connectors are properly mated but the reception is still poor, replace the antenna cable.
- If only FM reception is poor, it is unlikely that the antenna is at fault. Remove the radio for service.

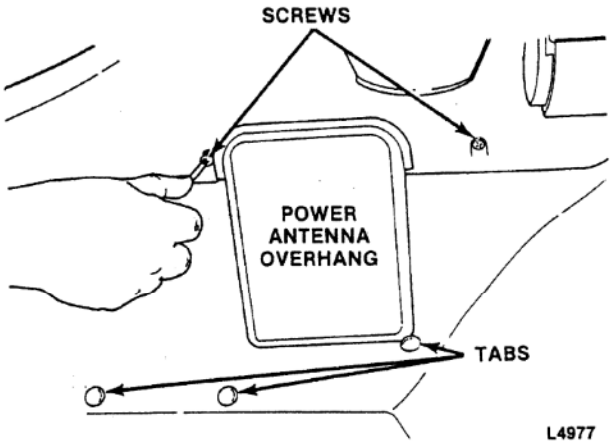
NOTE: Many customers do not understand the limitations of FM reception. Refer the customers to the Owner's Guide for information about the limitations of FM radio performance.

REMOVAL AND INSTALLATION

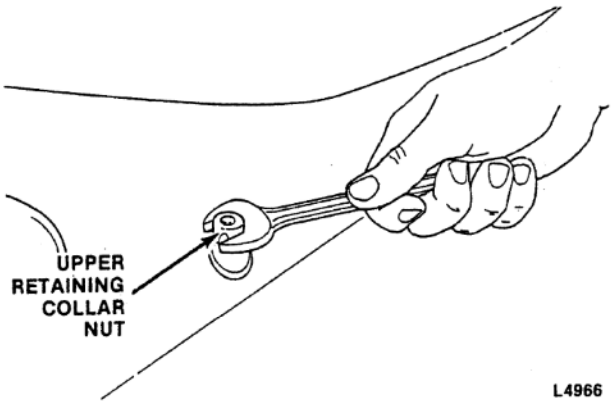
POWER ANTENNA

Removal

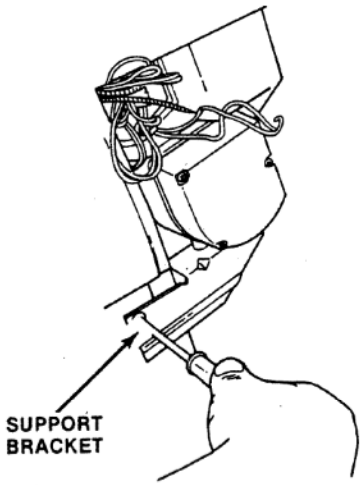
1. Unhook the left-hand side of the stowage net and lift away the left-hand side of the luggage compartment carpet.
2. From within the luggage compartment, remove the two screws and three tabs that hold the power antenna overhang. Pull back the rear quarter cowl trim panel and antenna overhang panel as an assembly.



3. Remove upper retaining collar nut on antenna. Remove bezel, spacer and sealing washer.



4. From within the vehicle, remove the screw retaining the support bracket.



DIAGNOSTIC CHART

Introduction

If the antenna motor constantly operates or makes noise without raising the antenna mast, replace the power antenna assembly. If the antenna is inoperative with no noise coming from the motor, perform the following diagnostic tests.

NOTE: The following tests are performed with the ignition in the accessory or run position and the radio on.

1. **Radio to antenna "UP" signal, at radio**

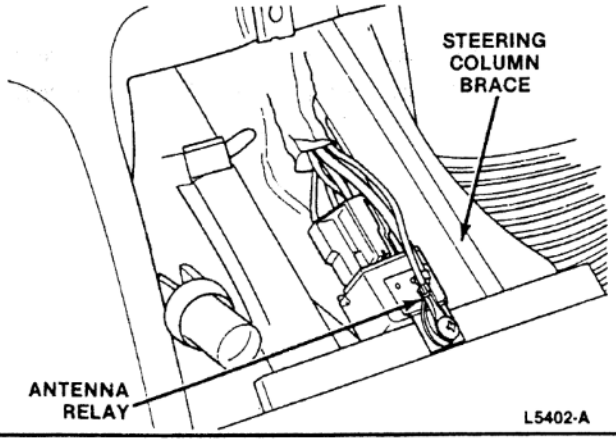
TEST STEP	RESULTS	ACTION TO TAKE
• Remove the radio. If necessary, refer to Section 35-03. • Do not disconnect radio wiring. • Check for voltage at the white wire.	VOLTAGE PRESENT VOLTAGE NOT PRESENT	Proceed to Step 2. Radio is at fault. Remove for repair.

CL5415-A1

DIAGNOSTIC CHART (Continued)

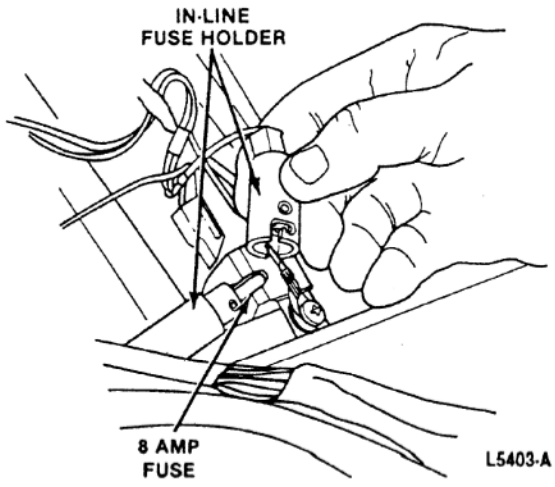
2. Antenna motor feed circuit, at relay outlet

TEST STEP	RESULTS	ACTION TO TAKE
• Remove the instrument cluster to gain access to the antenna relay. If necessary, refer to Section 33-50. • Check for voltage at the black wire.	VOLTAGE PRESENT VOLTAGE NOT PRESENT	Proceed to Step 5. Proceed to Step 3.



3. Antenna motor feed circuit, at relay inlet

TEST STEP	RESULTS	ACTION TO TAKE
• Check for voltage at the red wire.	VOLTAGE PRESENT VOLTAGE NOT PRESENT	Proceed to Step 4. No power supply. Follow the red wire and check the in-line fuse.



CL5415-A2

DIAGNOSTIC CHART (Continued)

4. Ignition switch to relay "OPEN" signal

TEST STEP	RESULTS	ACTION TO TAKE
• Unplug the relay connector. • Check for voltage at the black wire with a red tracer.	VOLTAGE PRESENT	Trace the wire back to the ignition switch to find where voltage is entering the circuit. Repair as necessary.
	VOLTAGE NOT PRESENT	Replace the antenna relay.

5. Antenna motor feed circuit, at power antenna assembly

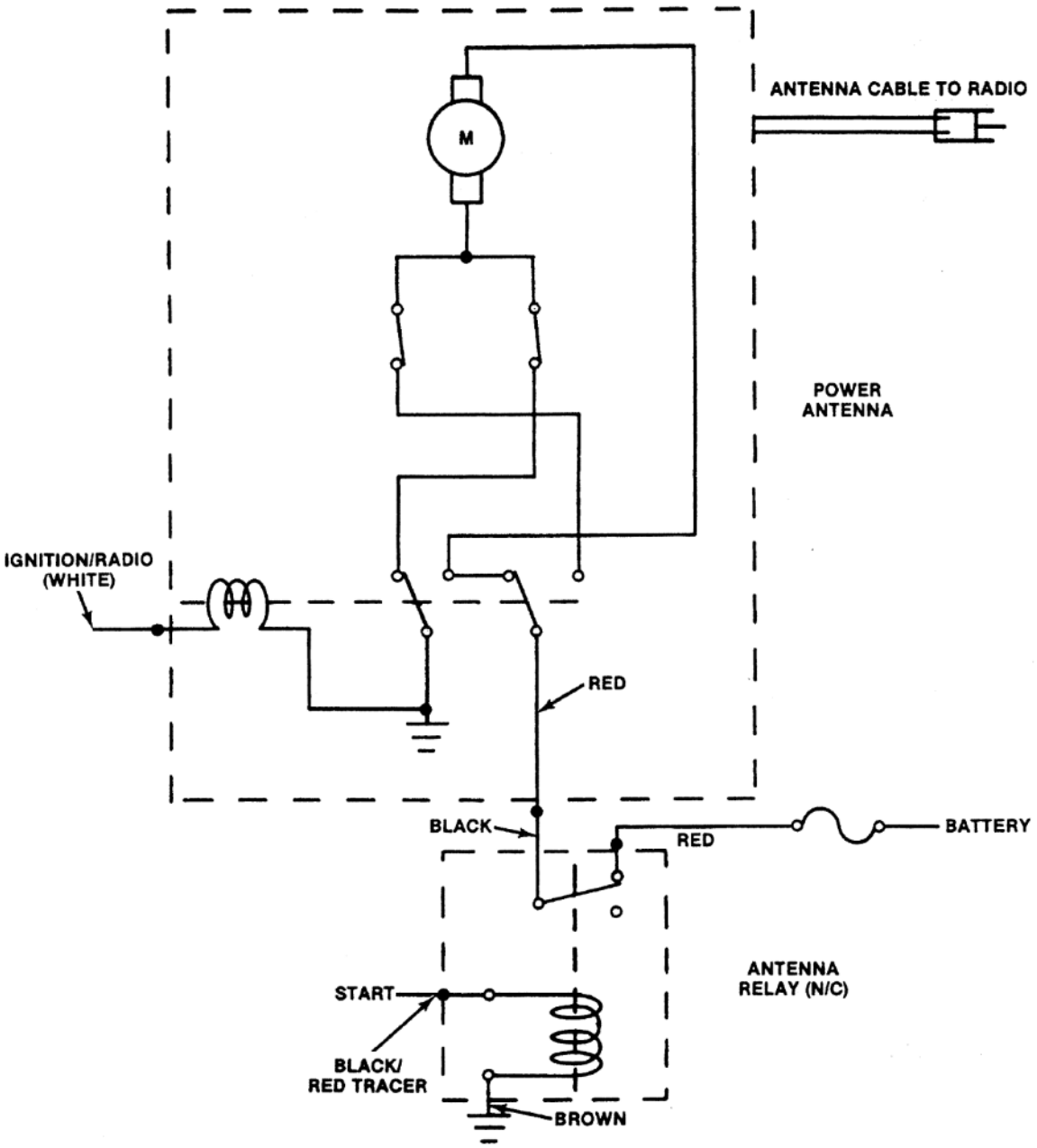
TEST STEP	RESULTS	ACTION TO TAKE
• Remove the upper and lower rear quarter trim panels to gain access to the power antenna assembly. If necessary, refer to the procedure in this section. • Check for voltage at the red wire.	VOLTAGE PRESENT	Proceed to Step 6.
	VOLTAGE NOT PRESENT	Trace the wire back to the relay to find the open in the circuit. Repair as necessary.

6. Radio to antenna "UP" signal, at power antenna assembly

TEST STEP	RESULTS	ACTION TO TAKE
• Check for voltage at the white wire.	VOLTAGE PRESENT	Replace the power antenna assembly.
	VOLTAGE NOT PRESENT	Trace the wire back to the radio to find the open in the circuit.

CL5415-A3

ELECTRICAL SCHEMATIC



NOTE: Circuitry shown in outlined box is contained in the antenna motor housing.

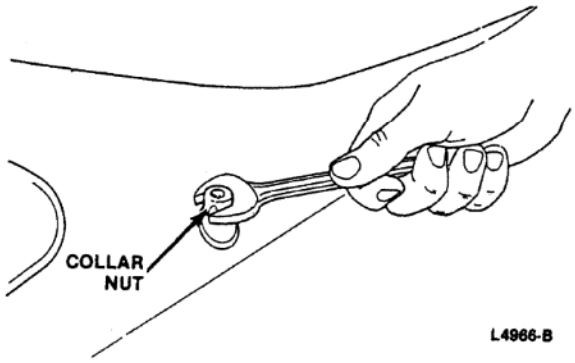
L5431-A

REMOVAL AND INSTALLATION

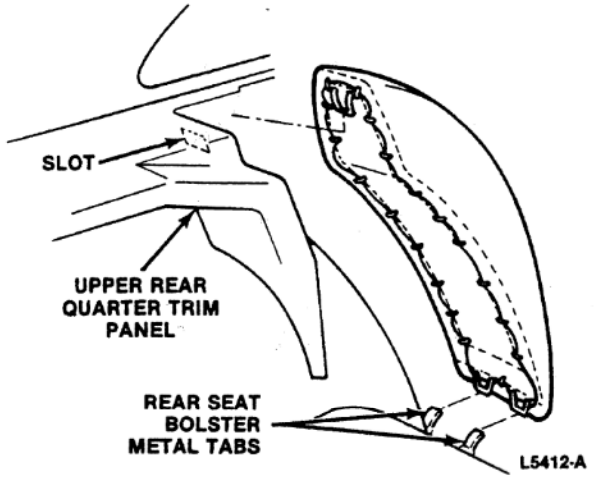
Power Antenna Assembly

Removal

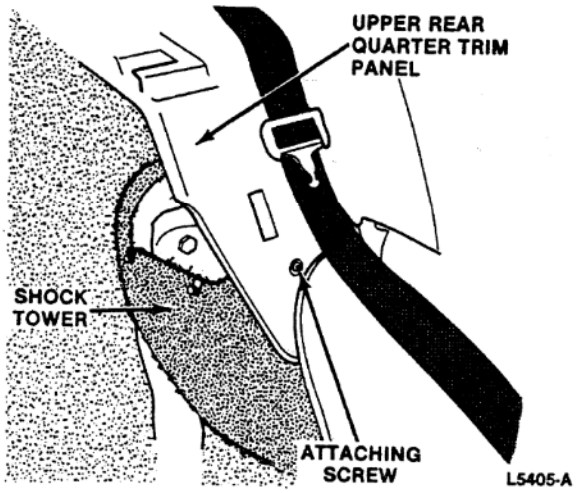
1. Remove the collar nut, stanchion and sealing washer securing the power antenna assembly to the left rear quarter panel.



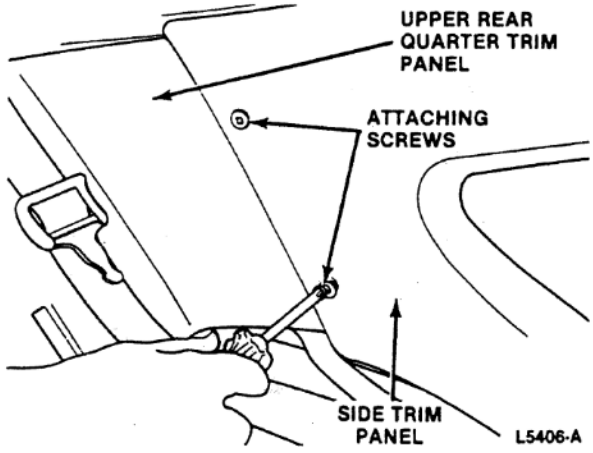
2. Remove the package tray.
3. Unhook the stowage net and remove the stowage area carpeting.
4. Working on the driver's side, remove the rear seat bolster as follows:
   a. Pull up the rear seat pad.
   b. Bend back the two metal tabs at the bottom of the bolster.
   c. Remove the bolster by pulling it straight up.



5. Remove the attaching screw securing the upper rear quarter trim panel to the shock tower.

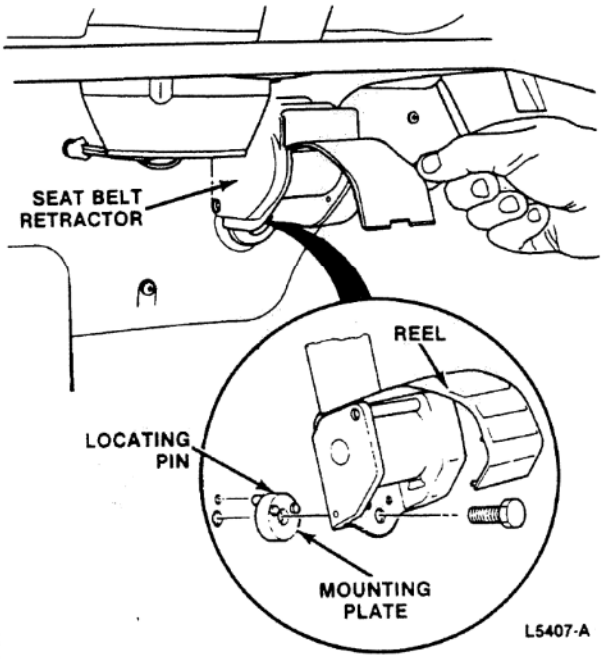


6. Remove the two attaching screws from the passenger rear seat trim panel.

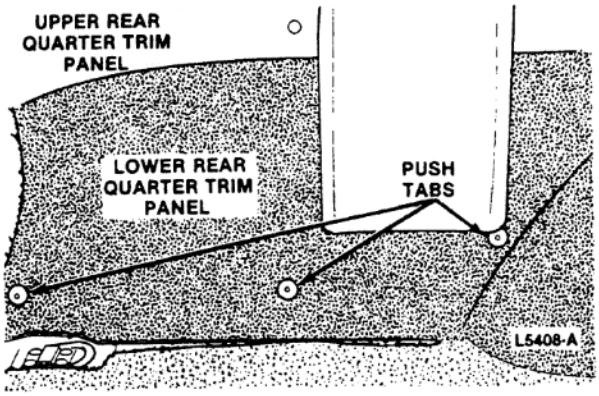


REMOVAL AND INSTALLATION (Continued)

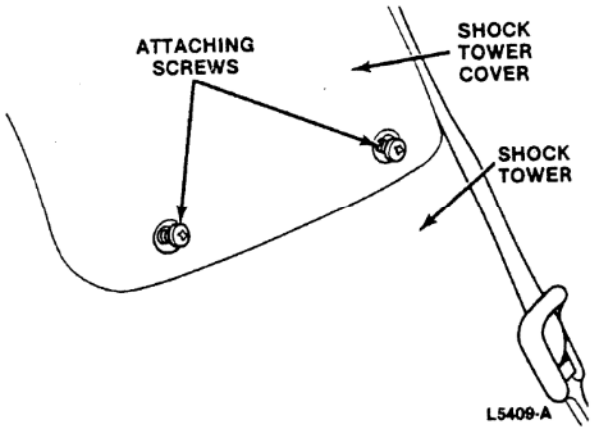
7. Remove the seat belt retractor.



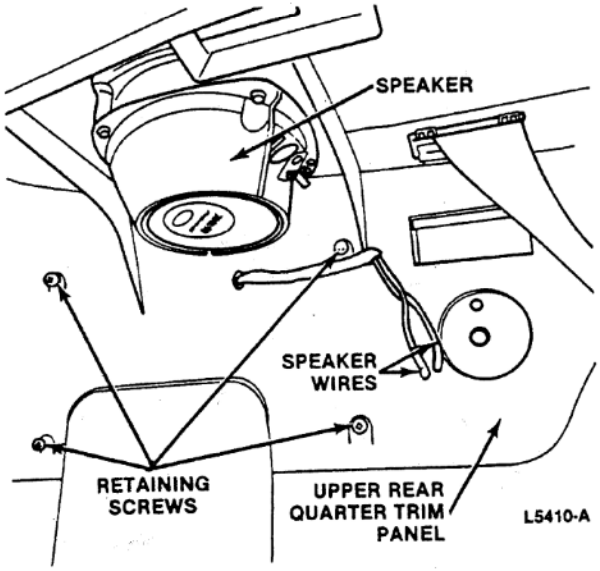
8. Remove the three push tabs from the lower rear quarter trim panel.



9. Remove the two attaching screws and cover from the shock tower.

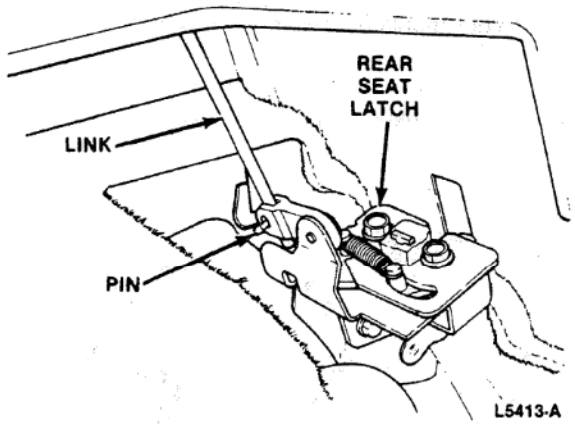


10. Disconnect the two speaker wires and remove the six remaining screws securing the upper rear quarter trim panel.

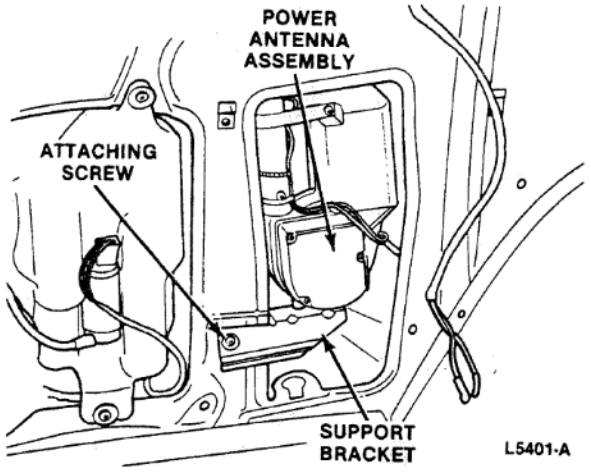


REMOVAL AND INSTALLATION (Continued)

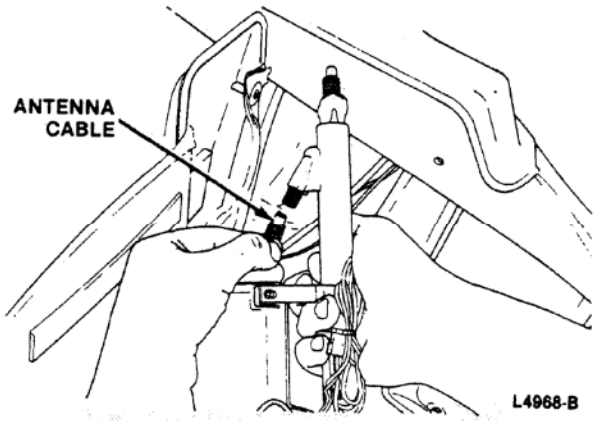
11. Pinch and remove the pin securing the link to the rear seat latch.



12. Remove the upper and lower rear quarter trim panels.
13. Remove the antenna support bracket attaching screw.



14. Disconnect the electrical connector and the antenna cable.
15. Remove the power antenna assembly from the quarter panel.



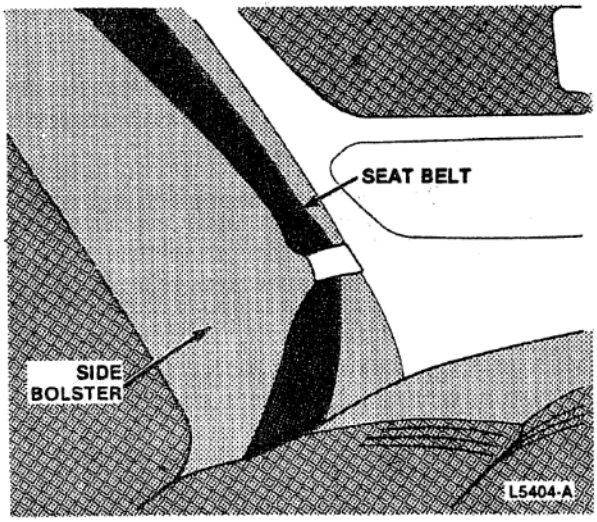
Installation

1. Position the power antenna assembly inside the rear quarter panel and install the attaching screw securing the support bracket.
2. Install the sealing washer, stanchion and collar nut, securing the power antenna assembly to the rear quarter panel.
3. Reconnect the electrical connector and the antenna cable. Check the operation of the antenna.
4. Install the lower rear quarter trim panel.
5. Install the upper rear quarter trim panel.

   Be sure the radio speaker wires are inserted through the hole in the trim panel.
6. Position the rear seat latch link and install the retaining pin.
7. Install the two attaching screws into the passenger rear seat trim panel.
8. Install the short attaching screw securing the upper rear quarter trim panel to the shock tower.
9. Install the six remaining screws securing the upper rear quarter trim panel.
10. Connect the speaker wires to the speaker and push the excess wire back through the hole in the trim panel.
11. Install the three push tabs into the lower rear quarter trim panel.

REMOVAL AND INSTALLATION (Continued)

12. Install the shock tower access cover and secure with two attaching screws.
13. Install the seat belt retractor.
14. Install the rear seat bolster as follows:
    a. Push the bolster straight down while pushing in at the top. The bolster hook should slide into the slot in the upper rear quarter trim panel.
    b. Secure the bolster with the two metal tabs at the bottom.
    c. Be sure the seat belt is routed over the bolster as shown.
15. Install the carpeting and stowage net.
16. Install the package tray.



Radio Speaker (Driver Side Lower-Instrument-Panel Mounted)

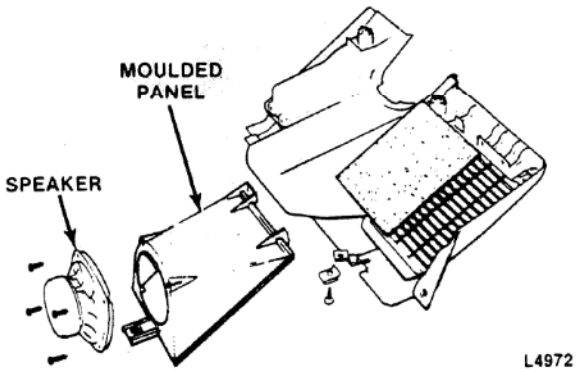
Removal

NOTE: The front left and right speakers are NOT interchangeable.

1. Remove lower instrument panel.
2. Remove screws retaining left-hand speaker to moulded panel.
3. Pull out speaker from moulding. Disconnect both leads.

Installation

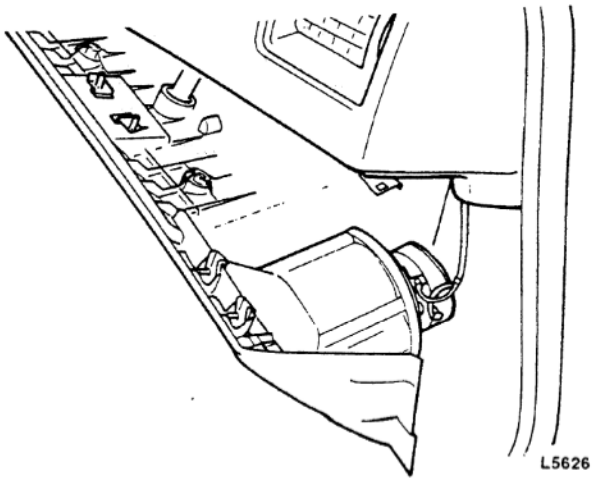
1. Reconnect speaker leads. Lead terminals differ in size to prevent incorrect connection.
2. Install left-hand speaker into lower-instrument-panel moulding and align screw holes. Install screws.
3. Install lower instrument panel.
4. Test speaker for proper operation.



Radio Speaker (Passenger Side Lower-Instrument-Panel Mounted)

Removal

1. Remove floor console to allow access to passenger side lower-instrument-panel pad retaining screws.
2. Remove eight screws retaining passenger side instrument panel.
3. Pull passenger side instrument panel far enough away from floor wall to expose speaker.
4. Remove four screws retaining speaker to moulded panel.
5. Pull out speaker from moulding. Disconnect both leads.



REMOVAL AND INSTALLATION (Continued)

Installation

1. Reconnect speaker leads. Lead terminals differ to prevent incorrect connection.
2. Install the speaker into moulded panel with four attaching screws.
3. Install the eight attaching screws securing the passenger side instrument panel.
4. Install the floor console.

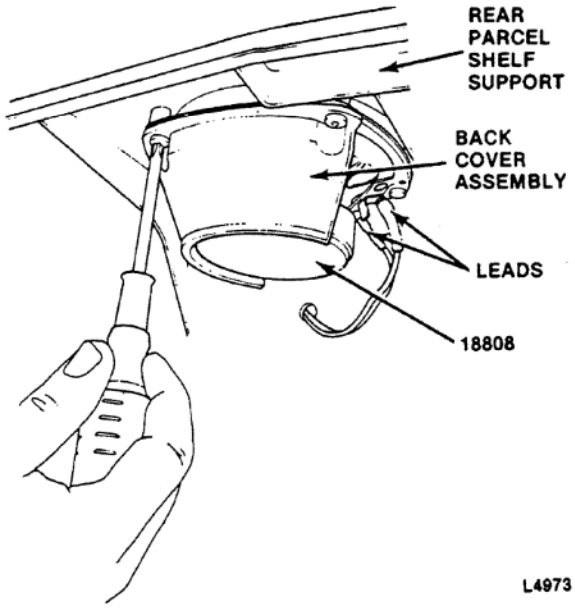
Radio Speaker (Rear-Parcel-Shelf Mounted)

Removal

1. Remove four screws retaining speaker to rear parcel shelf support and remove speaker and back cover assembly.
2. Detach back cover assembly and disconnect both leads.

Installation

1. Reconnect speaker leads. Reinstall back cover and align speaker to parcel shelf support.
2. Retain speaker with four screws. Test operation of the system.

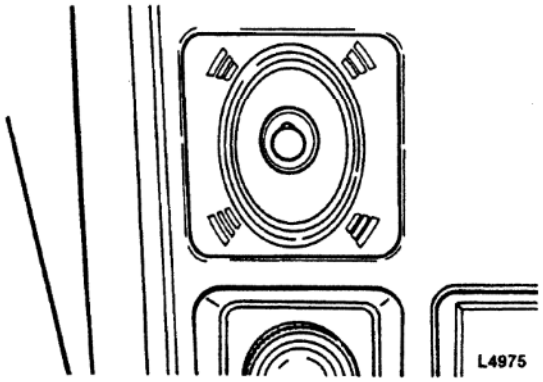


L4973

Speaker Balance Control Assembly

Removal

1. Carefully pry off the front plate with a thin-bladed screwdriver. Use pads to prevent scratch marks.
2. Twist assembly retaining ring counterclockwise and remove ring.



L4975

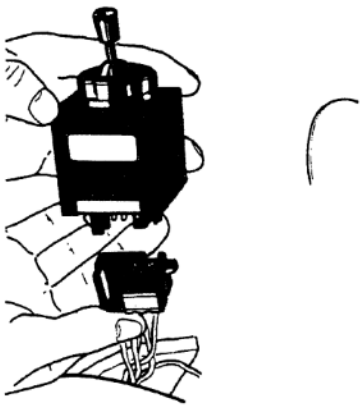
3. From behind lower console, slide assembly out of its housing and remove harness connector.

Installation

1. Reconnect harness connector.

NOTE: Harness connector can only be connected one way. Switch has a "T" shaped locating peg with a corresponding hole in the harness connector.

2. Slide assembly into its housing, and install retaining ring and front plate.



L4976

SECTION 35-40 ASH RECEPTACLES AND CIGAR LIGHTER

CONTENTS

	Page		Page
DESCRIPTION	1	REMOVAL AND INSTALLATION	
DIAGNOSIS	1	Ashtray Bulb	2
		Cigar Lighter Assembly	2

DESCRIPTION

The cigar lighter element has a low resistance heating coil which operates similar to the coil used in a portable heater. When the lighter is pushed in, the circuit is closed and the current flows through the coil to the ground. When sufficient heat is generated, the element will overcome the spring pressure of the bimetal retaining fingers and be released.

DIAGNOSIS

CIGAR LIGHTER INOPERATIVE

TEST STEP		RESULT	ACTION TO TAKE
A.1	INSPECT LIGHTER		
• Inspect lighter for burned out coil or other physical damage.		(OK) ▶	REPLACE element or socket as required.
		OK ▶	GO to A.2
A.2	CHECK FOR VOLTAGE		
• Using a voltmeter check for voltage at feed wire.		OK ▶	SERVICE ground circuit as required.
		(OK) ▶	CHECK feed circuit for an open or blown fuse. REPLACE or SERVICE as required.

CK5490-A

REMOVAL AND INSTALLATION

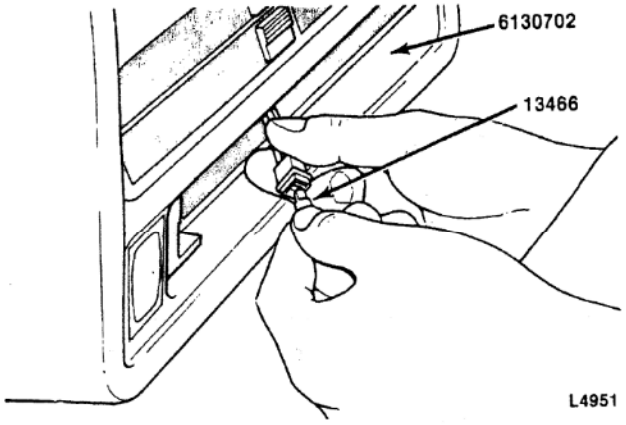
ASHTRAY BULB

Removal

1. Open the ashtray and remove the drawer from the housing.
2. Grasp the bulb holder and pull from the housing. The bulb is a wedge-base type and can be pulled out of the holder.

Installation

1. Install a new bulb into the holder and install the holder in the housing.
2. Install the ashtray drawer and check the operation of the system.



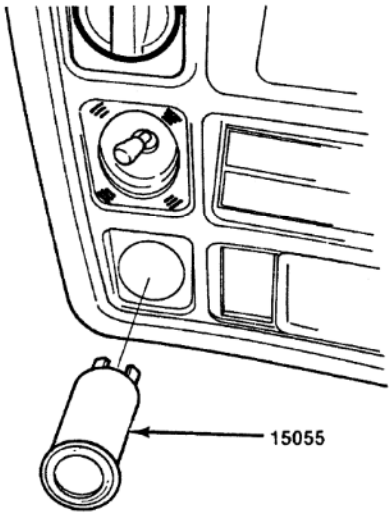
CIGAR LIGHTER ASSEMBLY

Removal

1. Remove the wiring harness from the rear of the lighter and push the lighter from behind the center console.
2. The bulb ring assembly can be withdrawn from the bulb holder after bulb holder removal.

Installation

1. Install the bulb holder and bulb ring assembly into the console. Push the lighter assembly into the bulb ring.
2. Reconnect the wiring harness.



SECTION 35-60 Windshield Wipers

SUBJECT	PAGE
ADJUSTMENTS	
Arm and Blade Assembly	35-60-3
DESCRIPTION	35-60-1
DIAGNOSIS	35-60-2
REMOVAL AND INSTALLATION	
Liftgate Wiper Motor	35-60-6
Windshield Wiper Blade Replacement	35-60-4

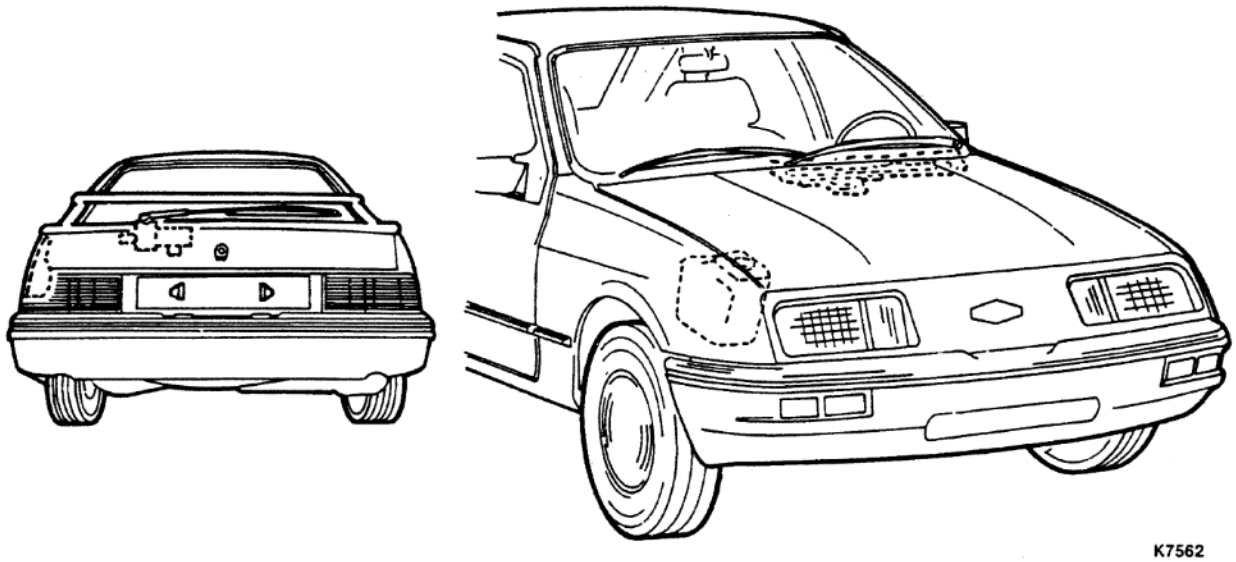
SUBJECT	PAGE
REMOVAL AND INSTALLATION (Cont'd.)	
Windshield Wiper Linkage	35-60-4
Wiper Motor	35-60-3
Wiper Switch	35-60-4
TESTING	
Wiper Motor Current Draw	35-60-2

DESCRIPTION

The front windshield wiper motor is located in the engine compartment and is directly connected to the wiper linkage. The motor is a two-speed, permanent magnet, non-depressed-park type and is operated by a lever-type switch mounted on the steering column. Intermittent operation is standard. The intermittent system circuit uses a timed relay and a rheostat switch. The switch can be adjusted by the driver to delay from five to twenty seconds.

A liftgate washer/wiper system is standard on the vehicle. The motor is a single-speed, permanent magnet, non-depressed-park type. The electric motor is mounted in the liftgate and is connected to a single wiper arm and blade. The spindle is mounted on the liftgate and protrudes from the liftgate outer panel to drive the wiper arm.

Electrically operated pumps supply both the windshield and liftgate washer systems. The reservoir for the windshield is in the engine compartment. The reservoir for the rear washers is located in the left-hand rear quarter panel behind the load compartment left-hand trim panel.

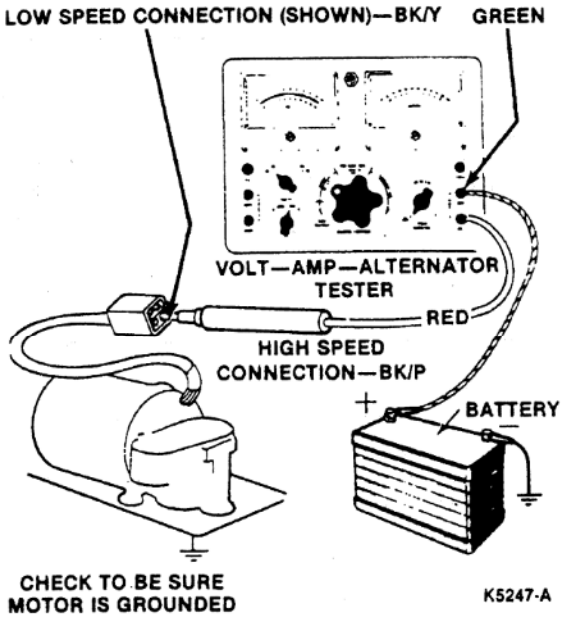


K7562

TESTING

Wiper Motor Current Draw

1. Disconnect the battery ground cable.
2. Disconnect the linkage and the electrical plug from the motor.
3. Connect the green lead from a volt-amp-alternator tester to the battery positive terminal.
4. Connect the red (positive) lead from the tester first to the low speed connection and then to the high speed connection. In both cases, current should not exceed three amperes.



DIAGNOSIS

ELECTRICAL — WIPERS AND WASHERS

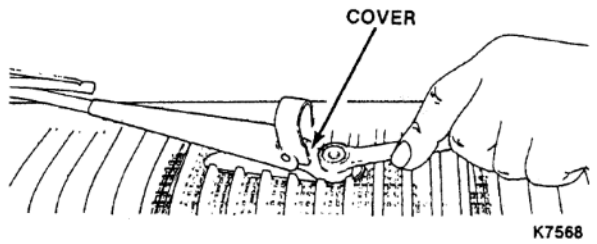
CONDITION (IGNITION ON)	POSSIBLE SOURCE	ACTION
• Windshield wipers inoperative in ALL switch positions.	**NOTE:** Check in sequence.	
	• Open circuit breaker.	• Check and replace if required.
	• Poor ground at wiper motor.	• Jumper motor case to car body. If motor now works service ground.
	• Switch.	• Test switch.
	• Bent or damaged motor linkage.	• Service as required.
	• Motor.	• Perform motor current draw test.
	• Open wire or connector.	• Service as required.
• Windshield wipers inoperative or erratic in LOW or INTERVAL (HIGH ok).	• Switch.	• Test switch.
	• Motor.	• Perform motor current draw test for low speed.
	• Open wiring.	• Check circuit
	• Poor interval wiper relay ground.	• Service as required (tighten attaching screws).
		• Check circuit
	• Inoperative interval wiper.	• Replace interval wiper relay.
• Wipers won't stop in OFF or INTERVAL	• Motor, switch, wiring or interval wiper assembly.	• Perform parking test.
• Interval systems only. No wipe(s) after wash.	• Circuit No. 941 (BK W) open.	• Service as required.
	• Interval wiper inoperative.	• Replace interval wiper relay.
Windshield washer does not operate.	• Low fluid level.	• Fill as required.
	• Split, loose, pinched or kinked hose.	• Inspect, service as required.
	• Open in wiring or switch.	• Service as required.
	• Washer pump.	• Replace seal and pump assembly.

CK5037-C

ADJUSTMENTS

Arm and Blade Assembly

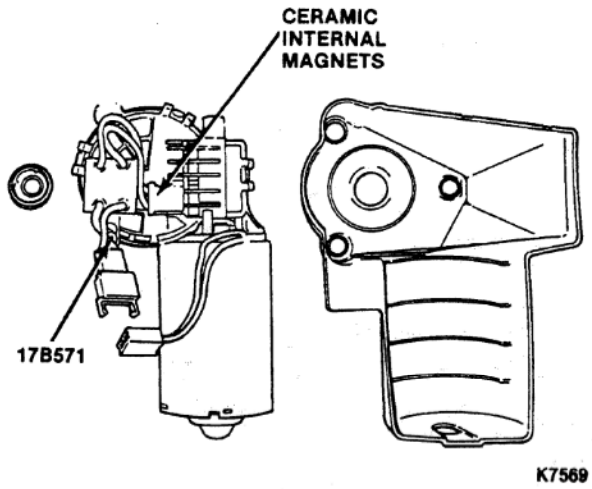
1. Remove the arm and blade assemblies from the pivot shafts by first lifting plastic cover, and then removing fixing nut with a 13mm spanner.
2. Turn on the wiper switch. Allow the motor to move the pivot shafts three or four cycles; then, turn off the switch. This will place the pivot shafts in the PARK position.
3. Install the arm and blade assemblies on the pivot shafts using the stops as a guide. Reverse removal procedure. Tighten fixing nut to 12 to 15 N·m (9 to 11 lb-ft).



REMOVAL AND INSTALLATION

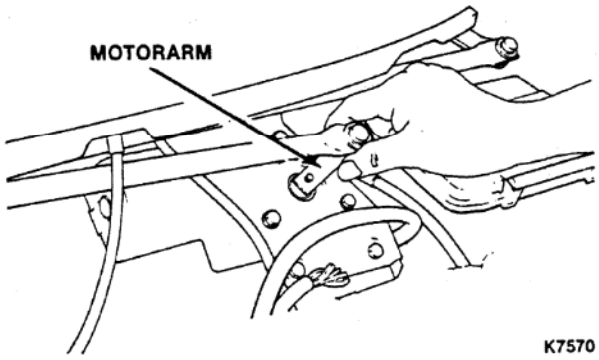
Wiper Motor

The internal magnets used in the wiper motor are a ceramic (glass-like) material. Use care when handling the motor to avoid damaging the magnets. The motor must not be struck or tapped with a hammer or other objects or placed in a vise.

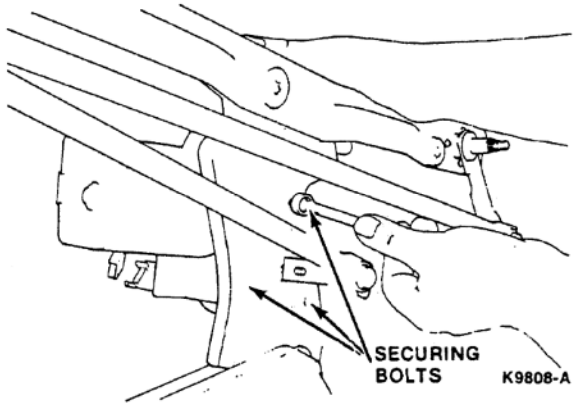


Removal

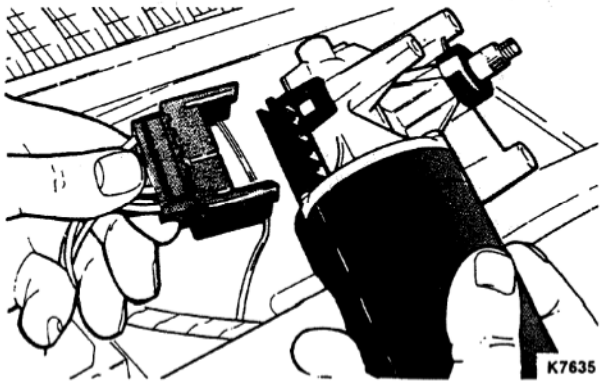
1. Turn the wiper motor ON. When the blades are straight up, turn the key OFF. Remove the arm and blade assemblies.
2. Disconnect the battery ground cable.
3. Remove the locknut from the motorshaft. Then, remove the motorarm from the motor.



4. Remove the three securing bolts; then remove the motor from the opening.



5. Disconnect the wiper motor's electrical connector.



REMOVAL AND INSTALLATION (Continued)

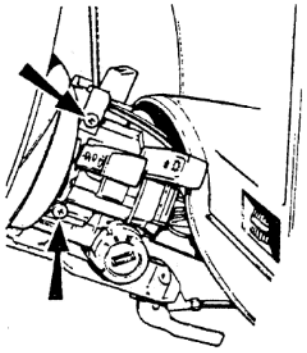
Installation

1. Reconnect the wiper motor's electrical connector.
2. Tighten all motor mounting bolts to 10 to 12 N·m (7 to 9 lb-ft).
3. Connect wiper motorarm to shaft of windshield wiper motor. Make sure the key of the motorarm is aligned to the shaft. Tighten locknut to 18 to 20 N·m (13 to 15 lb-ft).
4. Reconnect the battery ground cable.
5. Before installing the arm and blade assembly to the pivot shaft, cycle the motor to be sure it is in the PARK position.

Wiper Switch

Removal

1. Disconnect the battery ground cable. Remove the steering column upper and lower shrouds.
2. Remove the two phillips head screws and the guide switch assembly from the steering column.



K7639

3. Disconnect the two harness connectors from the switch. Remove switch from vehicle.

Installation

1. Connect the harness connectors to the switch.
2. Position the switch to the mounting bracket. Retain with two phillips screws.
3. Install upper and lower steering column shrouds. Reconnect the battery ground cable.

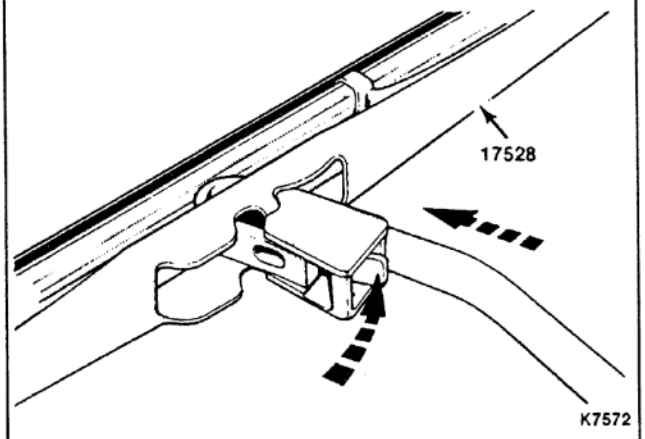
Windshield Wiper Blade Replacement

Removal

1. Lift the wiper arm away from the windshield. Position the wiper blade 45 degrees from the arm.
2. Depress the spring clip and slide the blade down and then up the wiper arm hook.

Installation

1. Slide the wiper blade onto the arm. Clip the arm and blade assembly into position.
2. Check wiper blade operation.

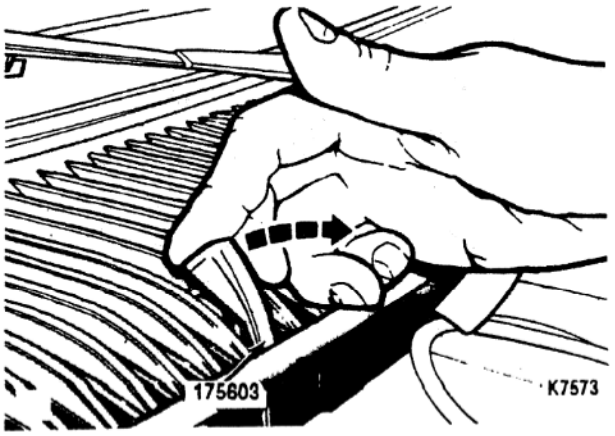


K7572

Windshield Wiper Linkage

Removal

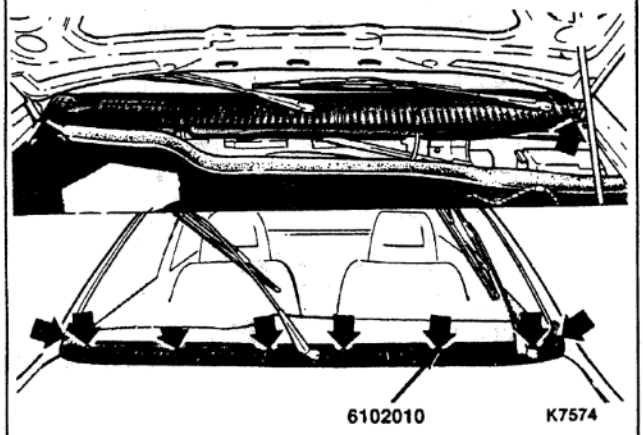
1. Disconnect the ground cable from the battery.
2. Remove wiper arms and blades.
3. Disconnect the windshield washer hoses from jets. Remove the screw from each end of the cowl top panel.



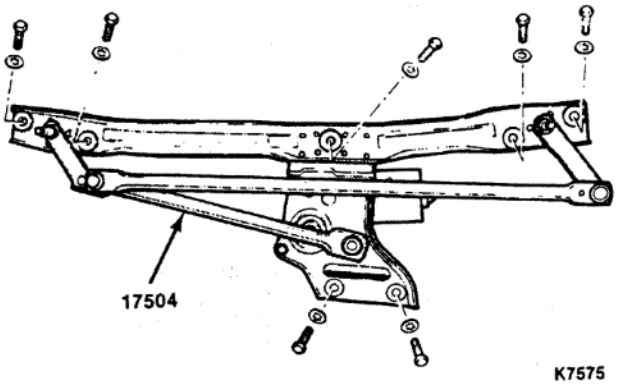
K7573

REMOVAL AND INSTALLATION (Continued)

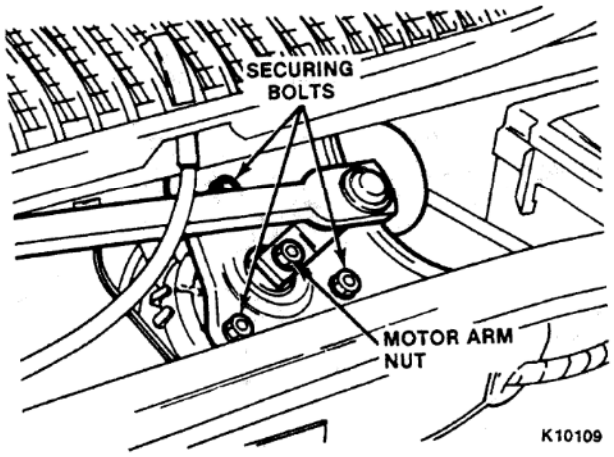
4. Remove the eight screw top panel covers and eight plastic screws holding the cowl top panel to the cowl top. Remove the cowl top panel.



5. Remove the bolts securing the wiper motor bracket to the body. Remove the linkage and windshield wiper motor. Disconnect wiper motor's electrical connector.



6. Remove the nut holding the motorarm to windshield wiper motor. Then remove motorarm from shaft. Then, remove the three bolts securing the motor to the bracket. Separate the motor from the linkage.



Installation

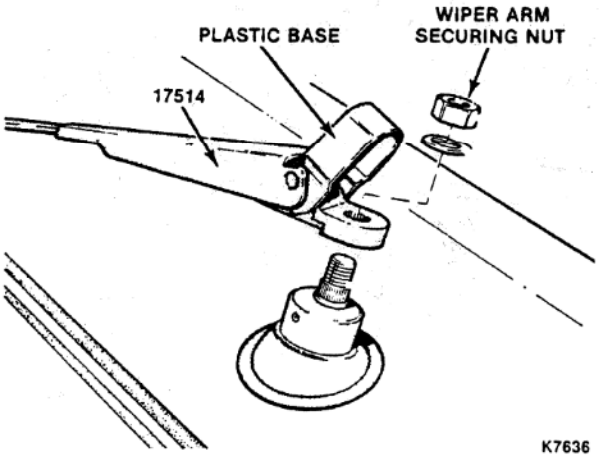
1. Connect the windshield wiper motor to the bracket with the three bolts. Tighten the bolts to 10 to 12 N·m (7 to 9 lb-ft).
2. Connect the motorarm to the motorshaft. Make sure the key of the motorarm is aligned to shaft. Tighten locknut to 18 to 20 N·m (13 to 15 lb-ft). Connect motor's electrical connector.
3. Attach the linkage and motor assembly to the vehicle. Tighten the seven retaining bolts to 6 to 7 N·m (4 to 5 lb-ft).
4. Align the cowl top panel with the retaining clips in the cowl top. Install the eight plastic screws and screw covers.
5. Reconnect the washer feed hose. Connect the cowl top panel with the two retaining screws.
6. Reconnect the battery ground cable.
7. Allow wiper motor to run three or four times to ensure PARK position.
8. Connect the wiper arm, washer, and nut to each spindle and align the arms as necessary. Tighten the nuts to 16 to 18 N·m (12 to 13 lb-ft).

REMOVAL AND INSTALLATION (Continued)

Liftgate Wiper Motor

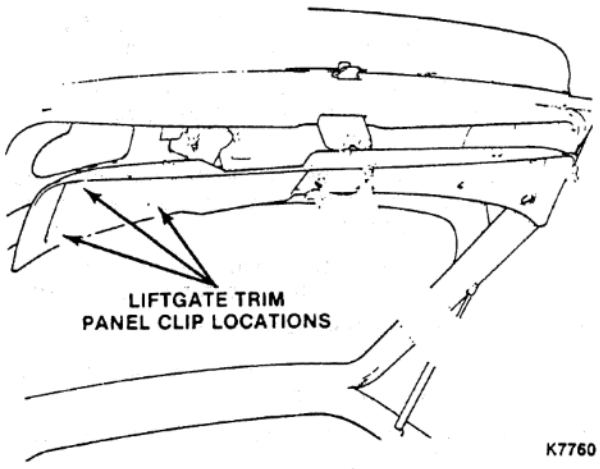
Removal

1. Unclip plastic clip from base of wiper arm. Unscrew wiper arm securing nut. Remove nut and washer.



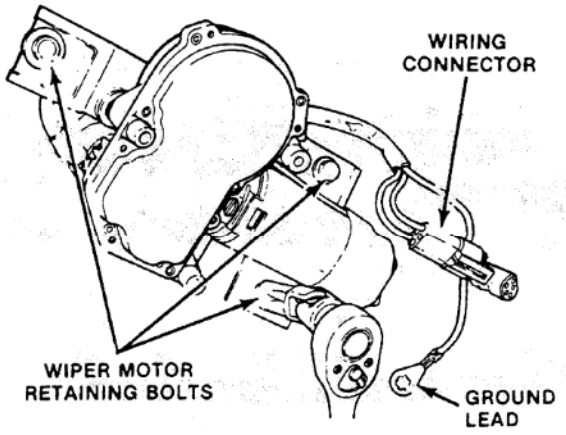
K7636

2. Open liftgate. Carefully pry out liftgate trim panel clips from their locations. Remove trim panel.



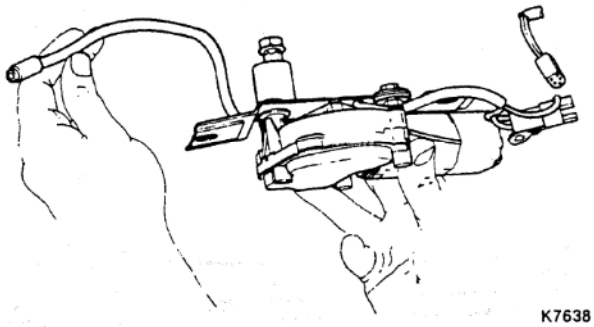
K7760

3. Remove three bolts holding wiper motor bracket of liftgate. Remove screw retaining ground lead and disconnect wiring connector.



K7637

4. Remove motor from liftgate. Disconnect rear washer supply hose from wiper.



K7638

Installation

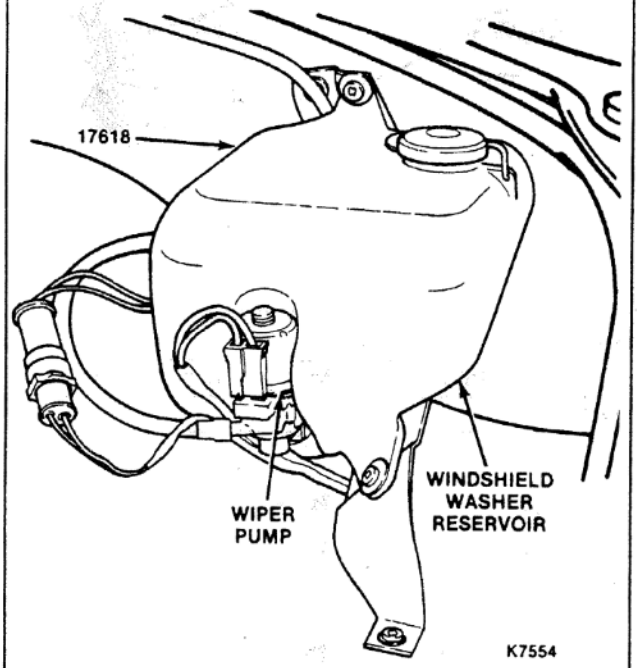
1. Reconnect rear window supply hose to wiper motor. Position motor in liftgate by pushing output shaft through grommet in liftgate outer panel. Tighten the three retaining bolts to 6 to 7 N·m (4 to 5 lb-ft).
2. Replace wiper arm and securing nut. Tighten nut to 16 to 18 N·m (12 to 13 lb-ft).
3. Replace liftgate trim panel. Check the operation of the system.

SECTION 35-70 Windshield Washers

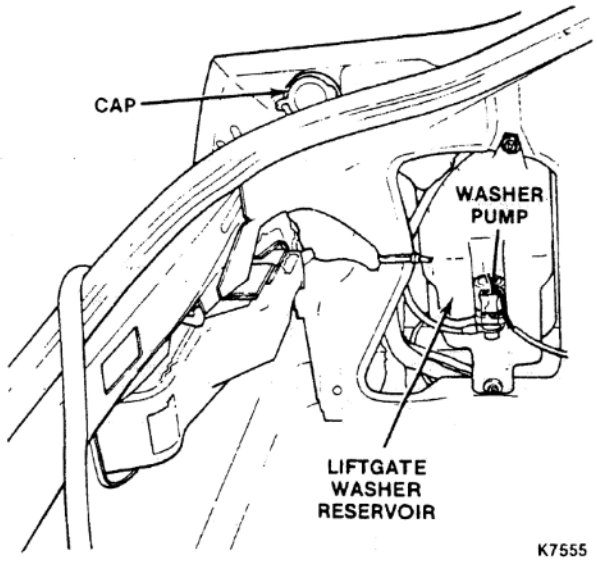
SUBJECT	PAGE
DESCRIPTION	35-70-1
DIAGNOSIS	35-70-2
REMOVAL AND INSTALLATION	
Liftgate Nozzle (1985 and 1986)	35-70-6
Liftgate Nozzle (1987)	35-70-6
Liftgate Washer Reservoir	35-70-5
Windshield Washer Nozzle	35-70-5
Windshield Washer Reservoir and Bracket	35-70-4
TESTING	
Washer Pump Current Draw	35-70-2

DESCRIPTION

Electrically operated pumps supply washer fluid to the windshield and liftgate washer systems. The reservoir for the windshield is in the engine compartment. The reservoir for the liftgate washer is located in the liftgate load compartment behind the left-hand rear quarter cowl panel.



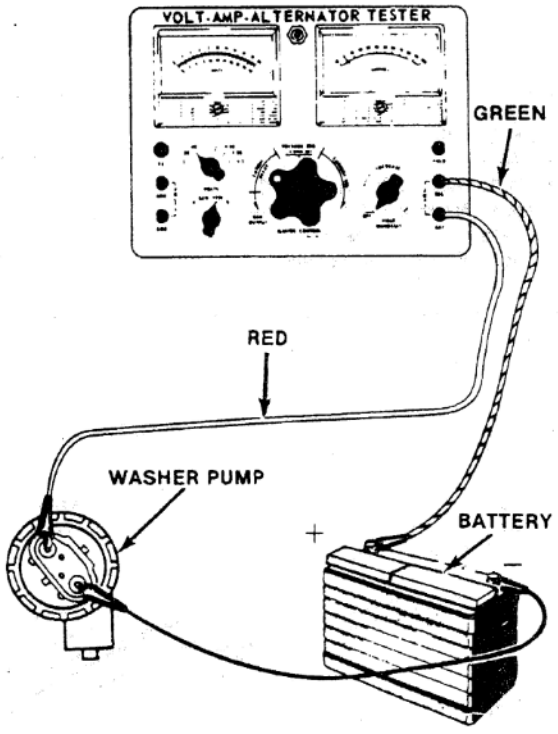
The windshield washer system consists of a control switch that is integral with the wiper motor assembly, the necessary hoses, nozzle, and attaching parts. The liftgate washer system has its own rocker switch for wiper/washer control.



TESTING

Washer Pump Current Draw

Attach the red lead of the volt-amp tester to the washer pump and the green lead to the battery. The current draw should not exceed four amps, or indicate less than two amps, while either of the washer pump motors are pumping fluid.



K2805-1B

DIAGNOSIS

LIFTGATE/WINDSHIELD WASHER DOES NOT OPERATE

TEST STEP		RESULT ▶	ACTION TO TAKE
A.0	LIFTGATE/WINDSHIELD WASHER DOES NOT OPERATE		
A.1	CHECK FLUID LEVEL		
• Check level of fluid in reservoir.		Empty ▶	FILL reservoir.
		(OK) ▶	GO to **A.2.**
A.2	ACTIVATE WASHER SWITCH		
• Activate washer switch.		Washer motor operates, but will not squirt fluid ▶	GO to **A.3.**
• Check washer motor for operation.		Washer motor inoperative ▶	GO to **A.5.**
A.3	INSPECT HOSE AND NOZZLE		
• Visually inspect washer hose and nozzle for blockage or hose kinks.		Hose or nozzle blocked or hose kinked ▶	CLEAN, REPLACE or SERVICE nozzle or hoses.
		Not blocked ▶	GO to **A.4.**

CL4611-B1

DIAGNOSIS (Continued)

LIFTGATE/WINDSHIELD WASHER DOES NOT OPERATE—Continued			
TEST STEP		**RESULT** ▶	**ACTION TO TAKE**
A.4	CHECK FOR BLOCKAGE AT WASHER PUMP OUTLET		
• Disconnect hose at reservoir and check for blockage at washer pump outlet.		~~OK~~ ▶	REMOVE washer pump from reservoir and CLEAN.
		OK ▶	REPLACE washer pump.
A.5	CHECK VOLTAGE AT WASHER PUMP		
• Using a voltmeter or test lamp, check for voltage at washer pump by activating washer switch.		No voltage ▶	GO to **A.7**.
		Voltage OK ▶	GO to **A.6**.
A.6	CHECK GROUND AT PUMP		
• Using an ohmmeter, check ground at washer pump.		Ground ~~OK~~ ▶	SERVICE ground.
		Ground OK ▶	REPLACE pump.
A.7	CHECK FOR POWER AT SWITCH		
• Check for power at wiper switch by operating wipers.		Wipers ~~OK~~ ▶	GO to **A.9**.
		Wipers OK ▶	GO to **A.8**.
A.8	CHECK FOR POWER OUT OF WASHER SWITCH		
• Using a voltmeter or test lamp, check for power out of washer switch or wash circuit.		No power ▶	GO to **A.11**.
		Power OK ▶	GO to **A.10**.
A.9	CHECK HEATER BLOWER		
• Activate heater blower.		~~OK~~ ▶	SERVICE open circuit in power feed wiring.
		OK ▶	GO to **A.10**.
A.10	CHECK WIPER/WASH CIRCUIT BREAKER		
• Check wiper/wash circuit breaker.		~~OK~~ ▶	REPLACE circuit breaker.
		OK ▶	GO to **A.11**.
A.11	CHECK SWITCH CIRCUITS		
• Check switch circuits.		~~OK~~ ▶	REPLACE switch.
		OK ▶	GO to **A.12**.

CL4611-A2

DIAGNOSIS (Continued)

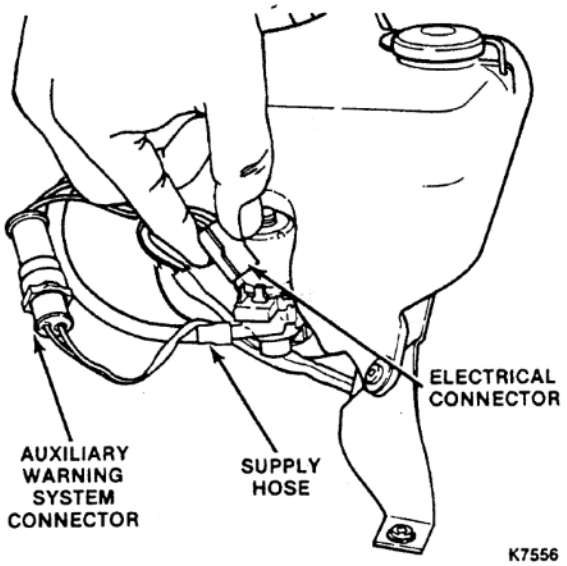
LIFTGATE/WINDSHIELD WASHER DOES NOT OPERATE—Continued			
TEST STEP		RESULT ▶	ACTION TO TAKE
A.12	CHECK FOR POWER TO SWITCH		
		No power ▶	CHECK for electrical system fault before wipe/wash switch.
		Power (OK) ▶	SERVICE wipe/wash wiring and connectors.
			CL4611-A3

REMOVAL AND INSTALLATION

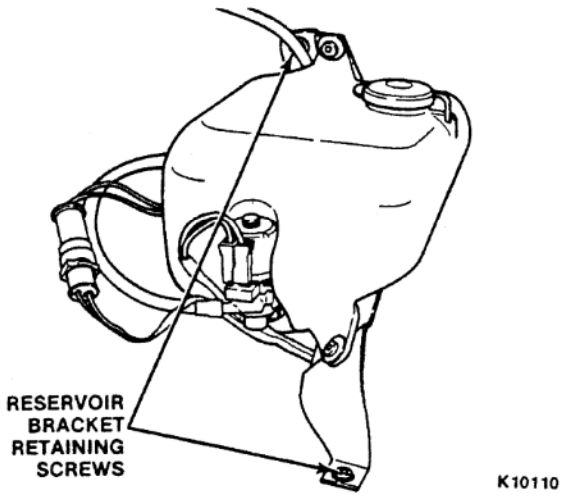
Windshield Washer Reservoir and Bracket

Removal

1. Drain or syphon washer fluid from the reservoir. Disconnect the washer pump and auxiliary warning system connector and hoses from the pump.



2. Remove the two reservoir bracket retaining screws. Remove the reservoir and its mounting bracket and detach the pump.



Installation

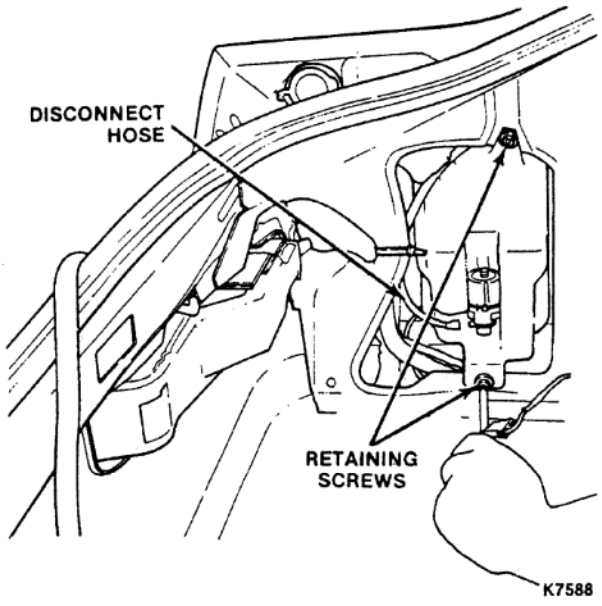
1. Attach the pump to the reservoir. Secure the reservoir assembly to the bracket with the retaining screws. Tighten the retaining screws to 1 to 1.5 N·m (0.7 to 1.1 lb-ft).
2. Reconnect the hoses to the pump and connect the supply wires.
3. Refill the reservoir and test the operation of the windshield washers.

REMOVAL AND INSTALLATION (Continued)

Liftgate Washer Reservoir

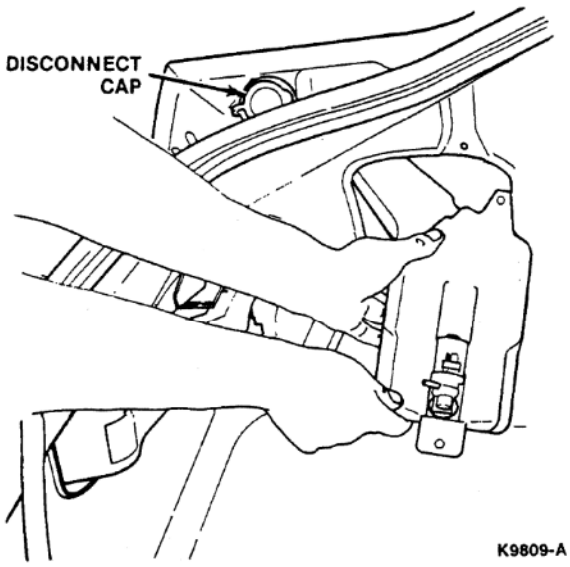
Removal

1. Open the liftgate and remove the left side trim panel.
2. Drain or syphon washer fluid from the reservoir. Disconnect the supply wires and hoses from the pump.
3. Remove the two phillips screws holding the reservoir. Remove the filler cap and remove the reservoir, taking care not to spill the washer fluid.



Installation

1. Refill the reservoir and install the filler cap. Attach the reservoir to the body with the two Phillips screws.
2. Install the left side trim panel and test the operation of the washer assembly.



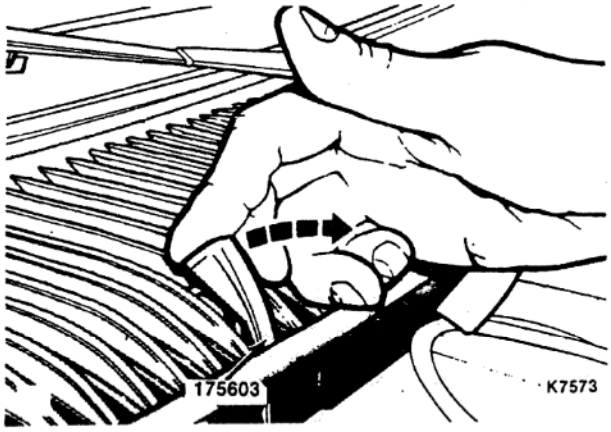
Windshield Washer Nozzle

Removal

1. Pull the nozzle forward to unclip it. Disconnect the hose and then remove the nozzle. An alternate method is to remove the nozzle with the help of a screwdriver at the bottom slot of the front face.

Installation

1. Reconnect the hose to the nozzle and push the nozzle assembly into the cowl top panel.
2. Adjust the nozzle as necessary.

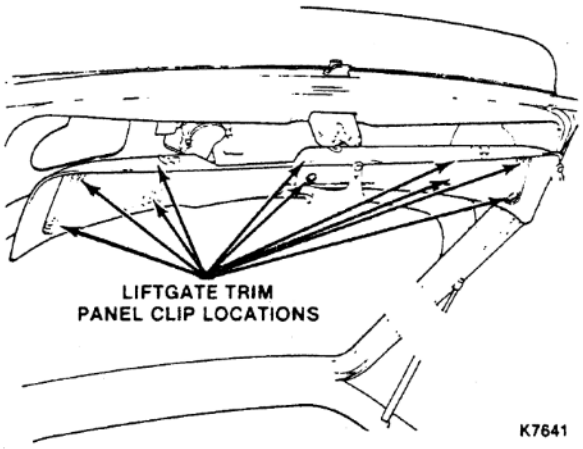


REMOVAL AND INSTALLATION (Continued)

Liftgate Nozzle (1985 and 1986)

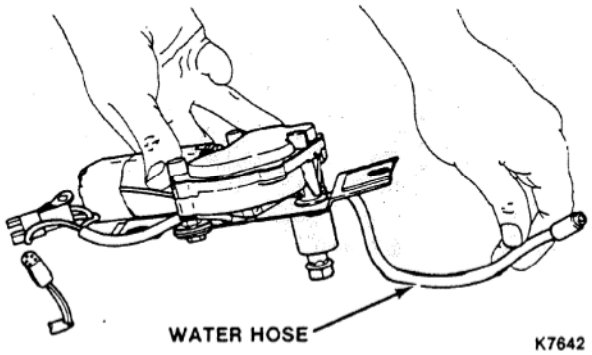
Removal

1. Remove the liftgate wiper arm and blade assembly.
2. Open the liftgate.
3. Remove trim panel.
4. Remove motor assembly fixing screws attached to inner panel.
5. Pull the motor assembly far enough away to disconnect the water hose from the nozzle connector. Remove the motor assembly from the liftgate.
6. Remove the cap and jet from the motor shaft.



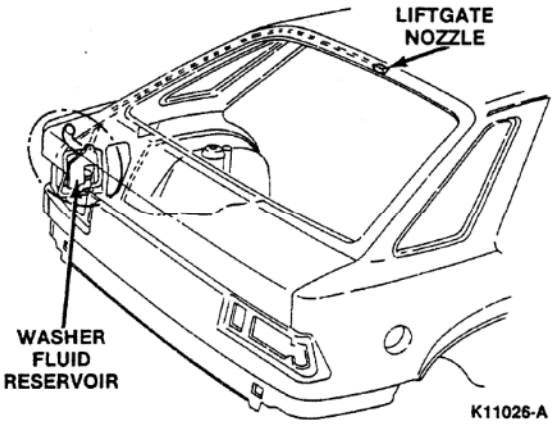
Installation

1. Push a new cap and jet onto the motor assembly.
2. Put a soapy water solution on the outer surface of the cap and jet.
3. Attach water hose to nozzle connection.
4. Attach motor assembly to inner panel. Attach fixing screws. Tighten to 9 to 11 N·m (7 to 8 lb-ft).
5. Replace wiper arm and securing nut. Tighten nut to 9 to 11 N·m (7 to 8 lb-ft).
6. Replace liftgate trim panel. Check the operation of the system.



Liftgate Nozzle (1987)

Liftgate nozzle location on 1987 XR4Ti is above the rear window.

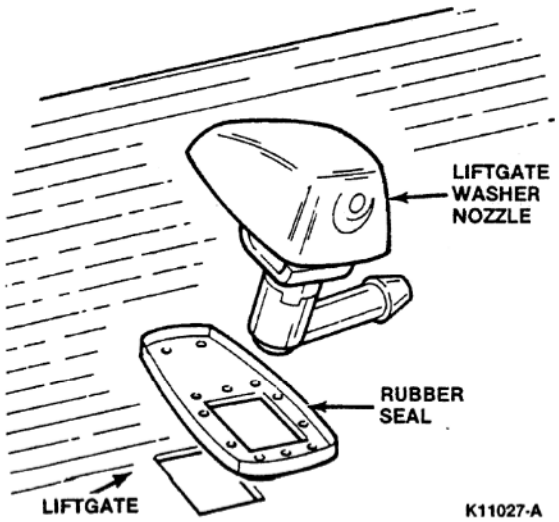


Removal

1. Pry nozzle out of opening in liftgate panel by inserting flat-bladed screwdriver between rubber seal and flat end of nozzle. Take care not to scratch finish on liftgate.
2. Pull hose from nozzle using twisting motion. Remove rubber seal.

Installation

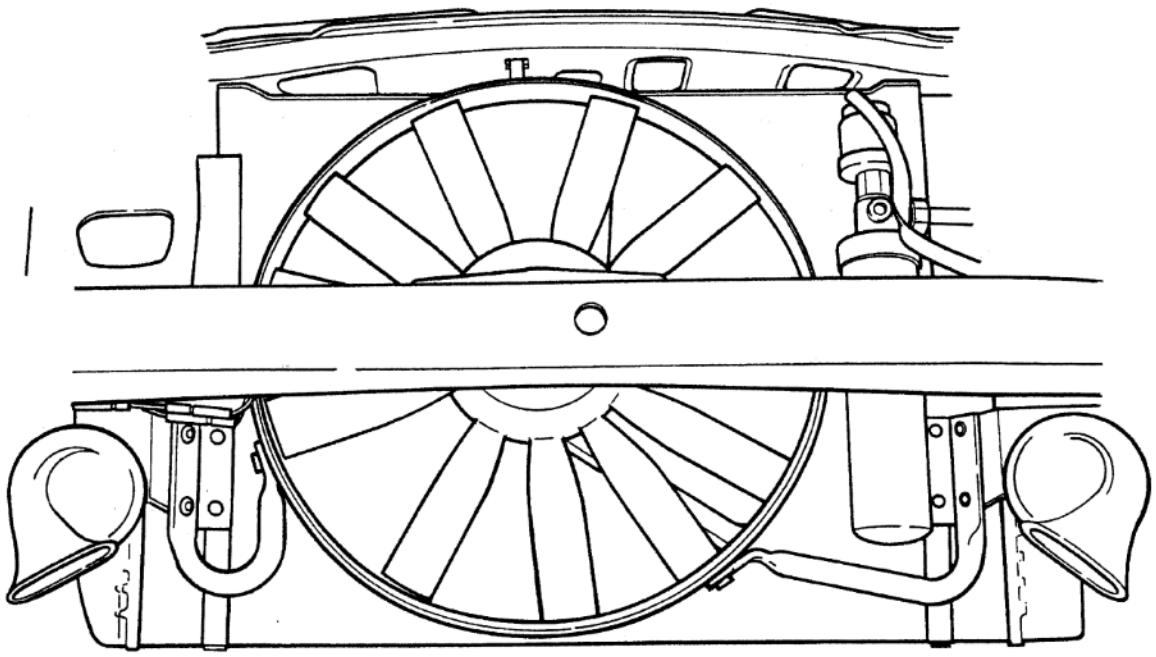
1. Position rubber seal over nozzle and push washer hose onto nozzle.
2. Position rubber seal and nozzle to liftgate panel. Push to engage nozzle retainer tabs.



SECTION 35-80 HORN

CONTENTS

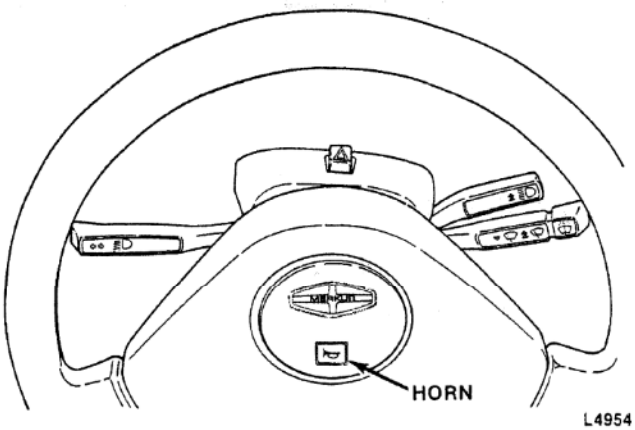
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Circuit Check	2
REMOVAL AND INSTALLATION	
Horn and Bracket	2
Horn Switch	3
Horn Slip Ring	4



L5057

DESCRIPTION

The horn and bracket assemblies are mounted in the forward part of the engine compartment below body side members (one each side). The horn switch is located inside the steering wheel cover over the center of the steering wheel and is operated by depressing the center cover.



TESTING AND ADJUSTMENT

CIRCUIT CHECK

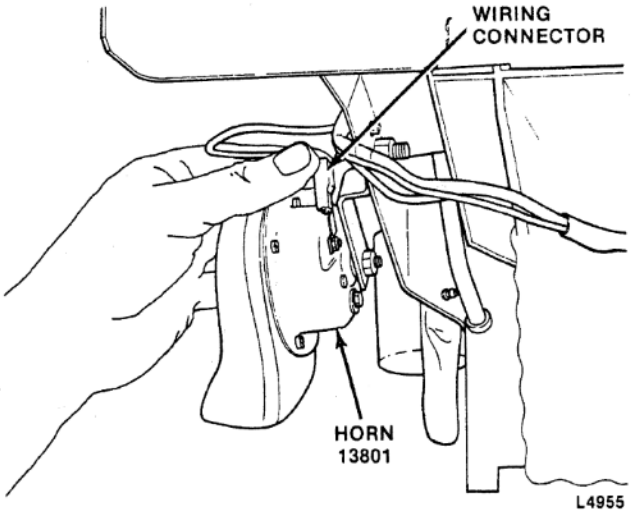
1. Verify that ground is good by checking the connection for corrosion and checking that the mounting screw is tight.
2. Attach a wire from the positive terminal of the battery to the horn. If the horn sounds normally, check the wiring to the horn and to the horn switch. If the horn does not sound, replace the horn(s).

REMOVAL AND INSTALLATION

HORN AND BRACKET

Removal

Disconnect the wiring connector and remove screw retaining horn. Remove horn.



Installation

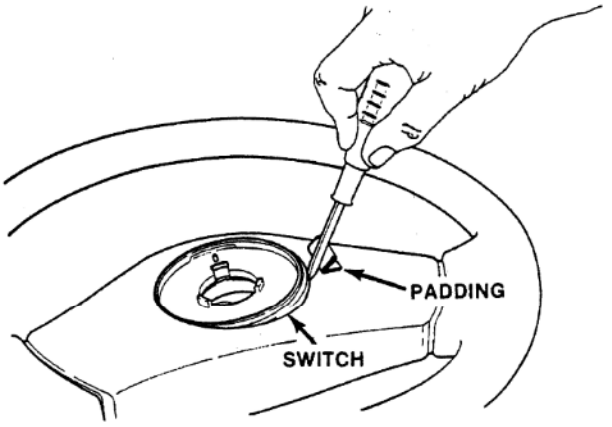
1. Position horn assembly and retain with screw fitted with a new toothed lock washer.
2. Reconnect wiring connector and test horn operation.

REMOVAL AND INSTALLATION (Continued)

HORN SWITCH

Removal

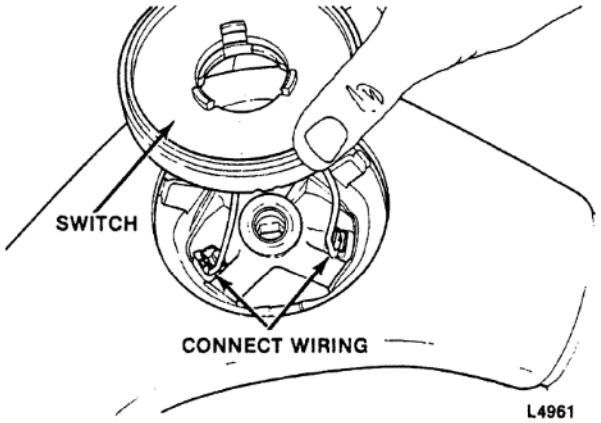
1. Disconnect the negative cable at the battery.
2. Pry off steering wheel hub cover. Pry off switch from center of steering wheel with a flat-bladed screwdriver.
3. Disconnect the wires from the slip ring.



L4956

Installation

1. Reconnect the wiring to the slip ring.
2. Push the horn switch back into the center of the steering wheel. Install the steering wheel hub cover.
3. Reconnect the negative cable at the battery and test horn operation.

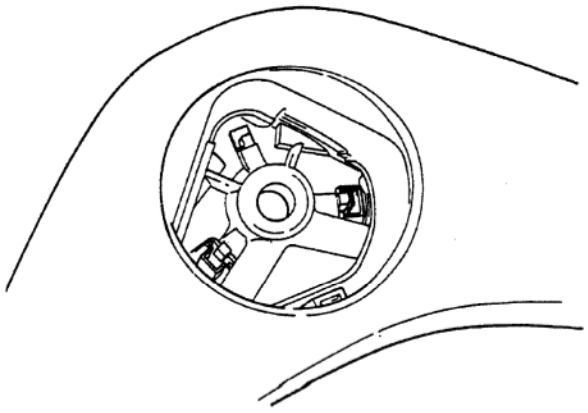


L4961

HORN SLIP RING

Removal

1. Remove the horn switch as detailed above.
2. Remove steering wheel attaching nut.
3. Remove the steering wheel from the steering wheel column.
4. Remove the slip ring from the steering wheel by prying the three lock tabs of the slip ring from its mounting.

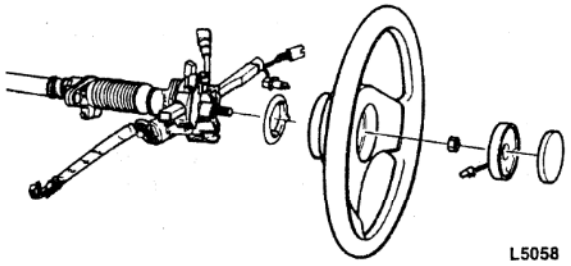

N4953

REMOVAL AND INSTALLATION (Continued)

HORN SLIP RING (Continued)

Installation

1. Install the slip ring in its mounting in the steering wheel by engaging the three lock tabs of the slip ring into the slots of the mounting.
2. Position steering wheel on steering wheel column.
3. Install steering wheel attaching nut.
4. Install horn switch as detailed above.



L5058

HEATING, VENTILATION, & AIR CONDITIONING

GROUP 36 (18000/19000)

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GROUP 36

SPECIFICATIONS 1

HEATING, VENTILATION, AND AIR CONDITIONING

GROUP 36

(18000 & 19000)

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DESCRIPTION AND OPERATION

Operation

The air conditioning system increases the comfort in the passenger compartment by:

- Cooling the incoming external air
- Cooling the recirculating internal air
- Cleaning the air
- Reducing air humidity

During operation, the air conditioning compressor pumps a metered quantity of pressurized liquid refrigerant into the evaporator core. The quantity of refrigerant passing into the evaporator is controlled by a temperature/pressure sensing expansion valve. Beyond the expansion valve, the refrigerant enters the low pressure portion of the system. Without the high pressure to keep it in a liquid state, the refrigerant boils. As the refrigerant vaporizes, it absorbs heat from the air flowing over the evaporator cores and fins.

The compressor draws the vaporized refrigerant out of the evaporator, compresses it, and directs it into the condenser in front of the radiator. The stored heat is then removed by the air flowing over the condenser cores and fins, which condenses the refrigerant from a gas back to a liquid.

The pressurized liquid then flows to the receiver/dryer. This unit acts as a reservoir and filter and extracts any moisture that may be in the system.

If the temperature in the evaporator rises, the expansion valve allows a larger quantity of refrigerant into the evaporator. This will reduce the temperature, and raise the pressure. The expansion valve now reduces the amount of refrigerant flow to the evaporator. The deicing thermostat is mounted on the evaporator housing and prevents evaporator icing during this temperature reduction.

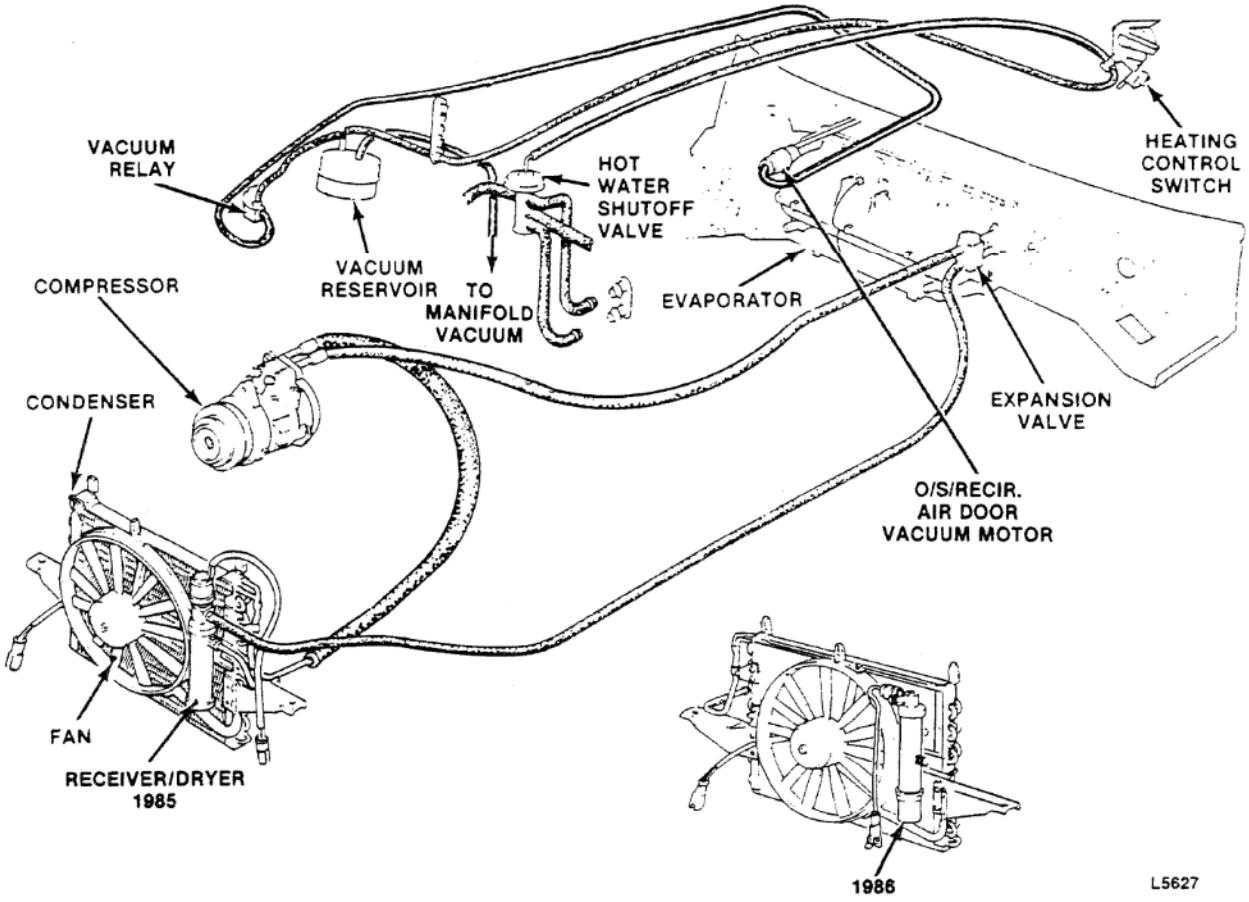
A temperature sensor measures the surface temperature of the cooling ribs of the evaporator. If the measured temperature drops below approximately -1°C (30°F), the thermostat disengages the electromagnetic clutch of the compressor. If it rises above 2.5°C (37°F), the compressor is switched on again.

As the operation of the compressor reduces the available engine power, the idling speed will drop when the air conditioning system is switched on. At this time, the EEC module receives a signal from the compressor to begin idle speed control.

If the system is switched to recirculated air, current is sent to a vacuum relay located in the right-rear section of the engine compartment. This relay routes vacuum to the O/S/RECIR. air door vacuum motor, which shuts off the supply of fresh air. Now only the interior air is circulated and cooled.

DESCRIPTION AND OPERATION (Continued)

When the temperature control lever is set to "cold," the supply of hot water to the heater core is interrupted by means of a valve which is controlled by a vacuum switch mounted on the control assembly. Now, only air cooled by the air conditioning system passes into the interior of the vehicle.



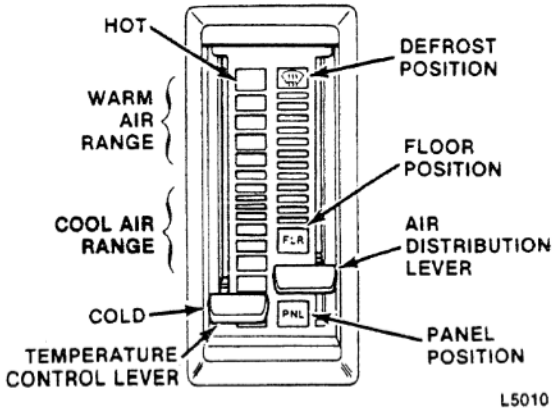
Control Lever Operation

The control levers adjust the desired temperature and system functions. The system will deliver heated or cooled air to maintain the vehicle interior temperature and comfort level. Blower speeds can be adjusted for more or less airflow as desired.

The temperature control lever (left side) regulates the air temperature inside the vehicle. The lower slide position (blue) is cold (outside air temperature or air conditioning) and the upper (red) position is hot or heated air. The lever may be set anywhere up or down the slide to vary the temperature as desired.

The air distribution lever (right side) controls the direction of airflow through either:

- DEFROST—The windshield defroster and side window deicer
- FLR (floor)—The floor registers: the intermediate position between the floor and defroster equalizes airflow through these outlets
- PNL (panel)—The panel registers: air flows through the instrument panel registers



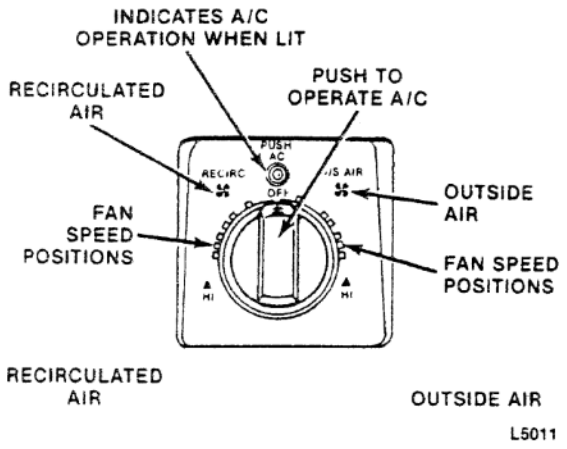
DESCRIPTION AND OPERATION (Continued)

The A/C-heater system has a combination fan and air conditioning rotary select switch located immediately below the control levers. This switch is a dual function switch. To use outside air for heating, defrosting, and ventilation, rotate the switch clockwise to select fan speeds as follows:

- I—Low speed
- II—Medium speed
- III—Maximum speed

To use the switch for air conditioning and fan speed, depress the switch and turn clockwise (outside air) or counterclockwise (recirculated air). A green LED will illuminate once the switch is depressed to indicate A/C mode. Depressing the switch a second time will switch the air conditioning off.

NOTE: The air conditioning system only operates when the rotary switch has been depressed and moved to one of the fan speed settings (for either O/S air or RECIR air).



System Airflow

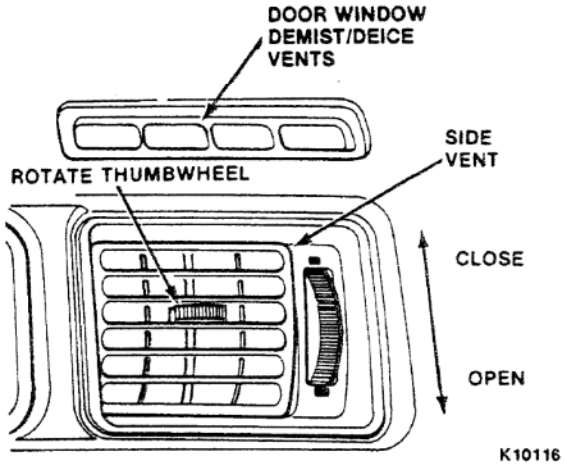
Air Distribution

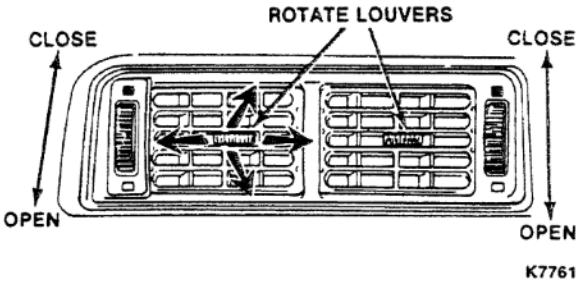
Distribution between the defroster and floor outlets is varied by means of the air distribution lever on the right-hand side of the control lever. With the lever down (PNL position), no air flows to the windshield or floor outlets. Air can only flow from the center or side vents with the appropriate adjacent thumbwheel turned to the open position.

When the air distribution lever is set to the symbol for defrost (full upper position), the air flows to the windshield, or with the lever set to the FLR position, the air will flow to the footwells. In these positions, air can additionally flow from the center or side vents with their appropriate thumbwheel turned to the open position. With the air distribution lever set between full upper (defrost symbol) position and the FLR position, the air flow can be varied to reach both the windshield and footwells simultaneously.

Door Windows Deice Vents/Side Vents and Center Vents

Rotate the appropriate adjacent thumbwheel to increase or decrease the amount of air flowing out of the side or center vents. Move the center knurled wheel to adjust the louvers and the direction of airflow. The door window demist/deice vents are not adjustable.





DESCRIPTION AND OPERATION (Continued)

Component Description

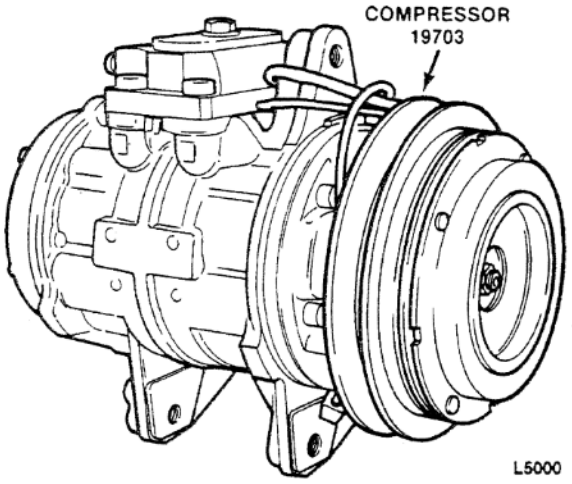
Listed below is a brief description of the A/C and heating components.

Compressor and Clutch

The Nippondenso 10P15 is a swash-plate design, five-cylinder (10 piston) compressor driven by a belt from the engine crankshaft. Displacement is 152.88cc (9.32 cu in.).

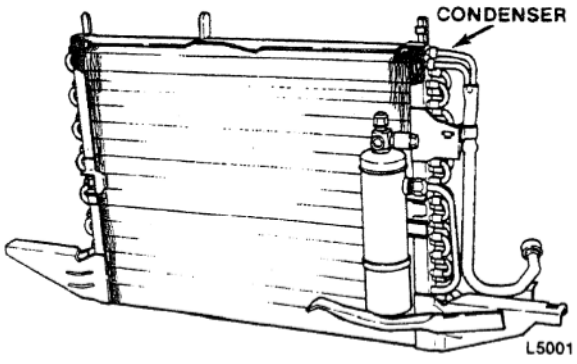
The suction and discharge valves are attached to the top of the compressor with two hex screws.

The clutch consists of three major components: the pulley, hub, and field coil. The pulley and field coil are attached to the front head of the compressor with tapered snap rings. The hub is keyed to the compressor shaft and is retained on the shaft by a 12mm nut.



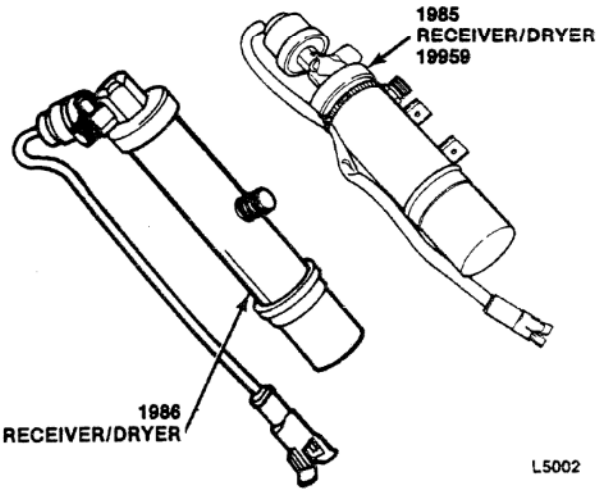
Condenser

The A/C condenser is an aluminum fin and tube design heat exchanger located in the front of the radiator. It cools compressed refrigerant gas by allowing air to pass over fins and tubes to extract heat and change the refrigerant from a gas to a liquid as it is cooled.



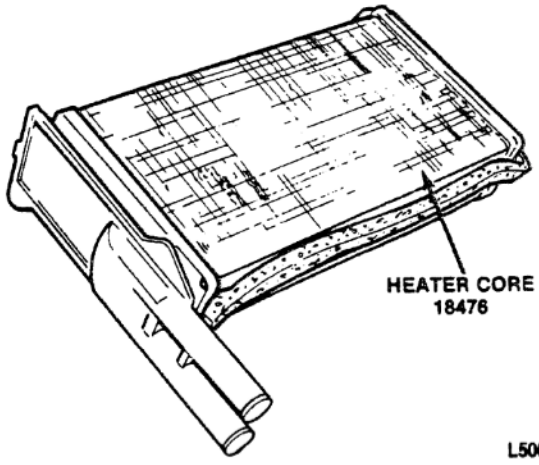
Receiver/Dryer

The receiver/dryer is mounted to the condenser. The inlet tube of the receiver/dryer attaches directly to the condenser. The receiver/dryer acts as a storage tank for liquid refrigerant which leaves the condenser. This ensures a solid flow of liquid refrigerant to the expansion valve. The receiver/dryer also contains a material called desiccant which acts as a dryer by absorbing moisture in the system. The unit has a sight glass for checking the condition of the refrigerant in the system.



Heating System

The heating system consists of an air inlet duct, a heater assembly and air control doors. The heater assembly is mounted to the dash panel below the instrument panel.

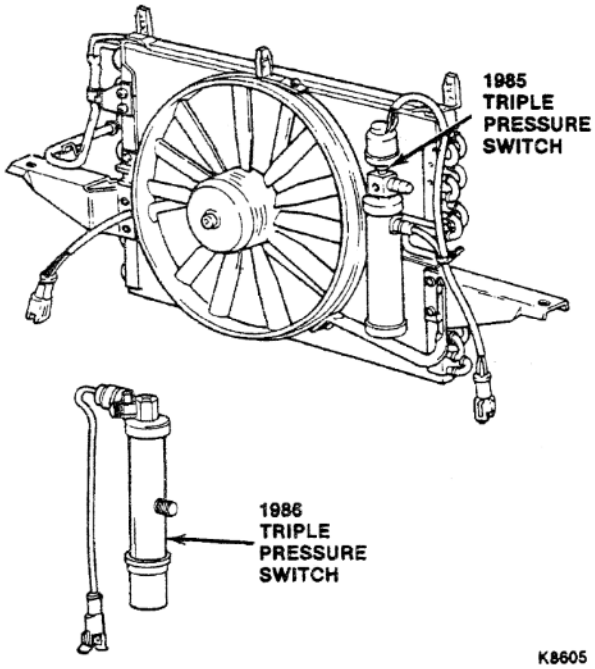


DESCRIPTION AND OPERATION (Continued)

Triple Pressure Switch

The triple pressure switch is mounted on top of the receiver/dryer and has three functions:

1. Engage the condenser blower if higher cooling performance is demanded. The pressure switch engages the blower at 1751 kPa (254 psi) and off at 1450 kPa (210 psi).
2. Switches off the compressor clutch at low pressure to avoid compressor damage in case of leakage and low ambient temperatures (below 1°C [30°F]) to avoid icing of the evaporator during winter driving conditions. The switch disengages the compressor clutch at 120 kPa (17 psi) and engages it at 220 kPa (41 psi).
3. Switches off the compressor at high pressure to avoid damage from excessive high pressure. The switch will disengage the compressor at 3000 kPa (435 psi) and engage it at 2300 kPa (334 psi).



Deicing Thermostat

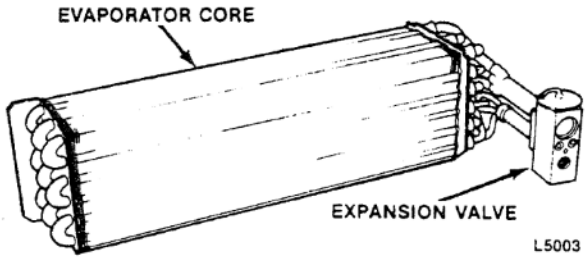
The deicing thermostat is located near the right side mount of the evaporator case. It senses the temperature inside the evaporator case through its thermostat sensor and will interrupt the circuit to the compressor clutch to prevent evaporator icing. The thermostat disengages the clutch at 0.5°C (32.9°F), and engages it at 3.5°C (38.3°F).

Expansion Valve

The expansion valve, positioned at the evaporator inlet/outlet, senses the temperature and pressure of the refrigerant at the evaporator outlet, then meters the appropriate amount of refrigerant into the evaporator.

Evaporator

The evaporator works as a heat exchanger. Air flowing through the evaporator is cooled, cleaned, and dried. The evaporator core is a fin/tube aluminum design. The mixture of refrigerant and oil enters the core via three tubes. The refrigerant leaves the core via three larger diameter tubes. These are formed into one tube and secured to the upper connection of the expansion valve.



Heating Shutoff Valve

The heating shutoff valve will shut off the supply of hot water to the heater core, whenever the temperature control lever is in the cold position.

Vacuum Relay

The vacuum relay applies vacuum to the recirculation/fresh air door for a recirculation position.

A/C Fan

The A/C fan is controlled by a thermal switch in the engine cooling system and the pressure switch on the receiver/dryer. The A/C fan switches on at 105°C (221°F) or 1750 kPa (249 psi), and switches off at 95°C (203°F) or 1400 kPa (199 psi).

Refrigerant Lines

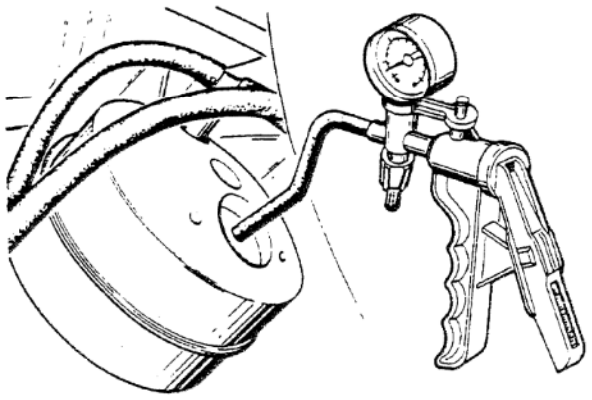
Refrigerant lines connect:

- Evaporator to compressor (low pressure)
- Compressor to condenser (high pressure)
- Receiver/dryer to expansion valve (high pressure)

SERVICE ADJUSTMENTS AND CHECKS

The effectiveness of the air conditioning system is partly dependent on the bowden cables being adjusted properly. Adjust the bowden cables and control flaps as described in this Section.

Ensure that all vacuum lines are secure and routed properly. Also check the vacuum reservoir for leads by connecting a vacuum pump.



L5628

Check the level of refrigerant in the air conditioning system at the sight glass. To do this, run the air conditioning system for at least 10 seconds, with the heater fan at speed III. If there are no bubbles at this time, the system is either empty, or full, or the compressor is not working. If bubbles can still be seen in the sight glass, the refrigerant is low.

The drive belt tension must be checked regularly and the condenser inspected for blockages (due to dirt, insects, etc.) and cleaned with water or compressed air.

During the winter months, the air conditioning system must be switched on once a month for about 10 minutes to keep the system seals intact. To do this, set the temperature control lever to "hot" and the air conditioning switch to "recirculated air" as otherwise the system will not operate.

NOTE: The compressor will not switch on if the temperature is below 0°C (32°F). (The pressure safety switch prevents this.)

The level of refrigerant in the air conditioning system must be checked at the sight glass every year at the start of summer, if possible, or every 20,000 km (12,000 miles). Always check for leaks using leak testing equipment.

The condition of refrigerant hoses and hose clips must also be checked, especially for chafing. The system should be topped off after about two years.

TESTING

Operation Test

Place a thermometer in the center vent and another measuring ambient temperature. Set the heater fan at speed II and the air conditioning switch to "recirculated air." Depending on the outside temperature, e.g. at about 18 to 24°C (64 to 75°F) the temperature of the air leaving the center vents should be approximately 6°C (43°F) after three to five minutes. If not, refer to the diagnostic procedure on 36-01-12.

The following tests may be made after checking for blown fuses, loose wire connections, damaged wires, or collapsed hoses. Always inspect for loose defroster ducts and air leaks in the body.

Blower Switch Continuity Test

Refer to appropriate electrical schematic. With an ohmmeter or self-powered test lamp, check for continuity between connected terminals, at every switch position. Also there should be no continuity between the power feed terminal and the switch case.

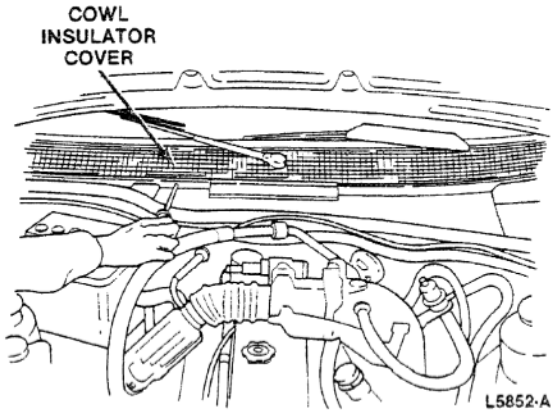
Open or Grounded Circuit Test

This test will locate an open or grounded circuit. Refer to the appropriate electrical schematic. With an ohmmeter or self-powered test light, check for continuity between any two points of a completed circuit, with the power removed from that circuit. If no continuity or slight continuity (high resistance) is shown, check for a poor connection or broken wire. If full continuity is shown, the circuit is complete. Also check that the circuit is not grounded by checking for continuity between the circuit and ground.

Heater Blower Motor Current Draw Test

This test will determine if the blower motor is operating properly.

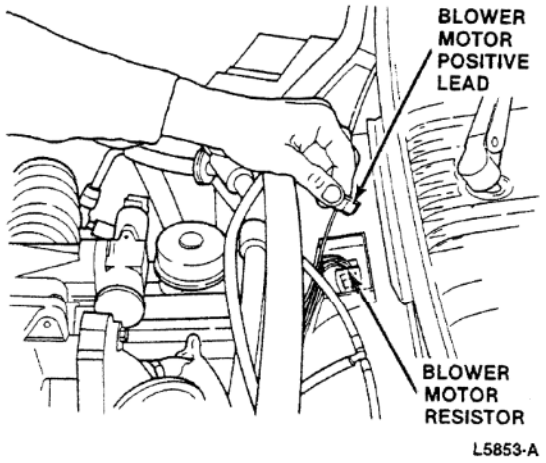
1. Remove cowl insulator cover.



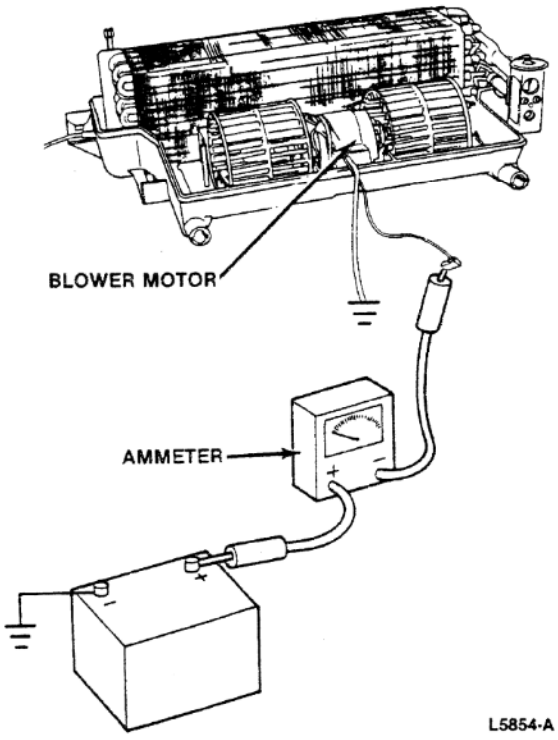
L5852-A

TESTING (Continued)

2. Disconnect the positive lead of the blower motor from the resistor block.



3. Using a 0-30 amp ammeter, connect the negative lead of the ammeter to the blower motor positive lead and the positive lead of the ammeter to the positive side of the battery.



4. If the motor is operating properly, the current draw readings should be:

   18-20 A — initial start-up

   10-12 A — running current draw

Plugged Heater Core Test

Check to be sure the engine coolant is at the proper level. Remove the heater hose from the heater core outlet tube and start the engine. Very little or no flow from the outlet tube indicates that the core is plugged.

Heater Core Leak Test

Inspection

1. Check for coolant leakage at the heater core attachments. A coolant leak at the hose could follow the heater core tube to the core and appear as a leak in the heater core.
2. If leakage is found, check for loose heater hose clamps. Clamp tightness is: 1.8 to 2.5 N·m (16 to 22 lb-in.).
3. If the hose clamps are tight, check the heater core tubes for distortion. Severe distortion of the tubes could cause leakage at the hose connection.

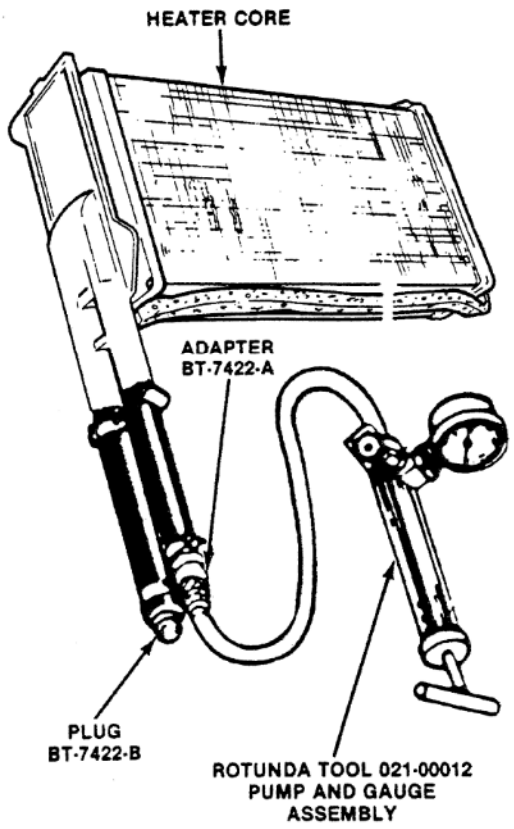
Pressure Test

1. Drain the coolant from the cooling system.
2. Disconnect the heater hoses from the heater core tubes.
3. Install short pieces of heater hose (approximately 100mm [4 in.] long).
4. Fill the heater core and hoses with water. Install plug BT-7422-B and adapter BT-7422-A from Rotunda model 021-00012, or equivalent, in the hose ends. Secure the hoses, plug, and adapter with hose clamps.
5. Attach the pump and gauge assembly Rotunda model 021-00012, or equivalent, to the adapter. Close the bleed valve at the base of the gauge. Pump 200 kPa (30 psi) of air pressure into the heater core.
6. Watch the pressure gauge for a minimum of three minutes. The pressure should not drop.
7. If the pressure does not drop, no leaks are indicated.
8. If the pressure drops, check the hose connections to the core tubes for leaks. If the hoses do not leak, remove the heater core from the vehicle and bench test the core as outlined below.

TESTING (Continued)

Bench Test

1. Drain all coolant from the heater core.
2. Connect the 100mm (4 in.) test hoses with plug and adapter to the core tubes. Then, connect the air pump and gauge assembly to the adapter.
3. Apply 200 kPa (30 psi) of air pressure to the heater core with Rotunda model 021-00012, or equivalent. Submerge the core in water.
4. If a leak is observed, service or replace the heater core as necessary.



L2867-1A

DIAGNOSIS

Air Conditioning System

DIAGNOSIS CHART

CAUSES	1. No cooling	2. Insufficient cooling	3. Compressor vibrating and noisy	4. Excessive drive belt wear	5. Compressor not working	6. Clutch slipping	7. Heater fan on evaporator not working	8. Water entering vehicle interior	9. Pressure too high (high-pressure side)	10. Pressure too low (high-pressure side)	11. Suction too high (low-pressure side)	12. Suction too low (low-pressure side)	13. Engine overheating	14. Bubbles in sight glass after 5-10 secs idling
1. Broken drive belt	X				X					X				
2. Loss of refrigerant		X			X				X		X		X	
3. Loose or worn drive belt		X	X	X					X	X			X	
4. Compressor clutch slipping			X											
5. Faulty deice thermostat	X				X									
6. Rotary air conditioning and fan switch not working	X				X		X							
7. Compressor not working	X													
8. Dirty condenser		X							X				X	
9. Heater fan on evaporator not working	X													
10. Foreign matter or damaged parts in compressor	X	X	X	X	X	X				X	X			
11. Broken or loose compressor bracket			X	X										
12. Excessive refrigerant delivery/faulty expansion valve		X	X	X		X			X		X			X
13. Oil on drive belt		X		X						X				
14. Blown fuse	X				X		X							
15. Loose wire connection or broken wire	X				X		X							
16. Faulty field winding	X				X	X								
17. Compressor pressure too high			X	X		X								
18. Loose drive belt pulley		X	X	X						X				
19. Heater fan motor seized	X						X							
20. Blocked or kinked drainage valve hose								X						
21. Air or moisture in refrigerant circuit		X							X			X		
22. Condenser air flow obstructed		X							X				X	X
23. Faulty valves in compressor cylinder head		X	X							X	X			
24. Constriction in dehydrator		X							X			X		
25. Faulty compressor diode or loose contact*	X				X									
26. Faulty three-function pressure switch	X				X									
27. No refrigerant in system	X				X									
28. Loose compressor clutch		X	X											
29. Faulty seals between evaporator housing and cowl panel								X						
30. Condenser auxiliary fan not working									X		X		X	X
31. Loose compressor field winding mounting		X	X	X										

***NOTE:** If the compressor diode is faulty or inoperative, the deice thermostat will be damaged.

CL5601-A

DIAGNOSIS (Continued)

Inadequate, erratic or non-existent cooling are the complaints most often encountered with the air conditioning system. To diagnose a fault correctly, the following procedure should be applied:

1. Close both hand valves on the manifold gauge set.
2. Connect a manifold gauge set.
3. Place the air conditioning system in operation:
   a. Set the air conditioning system to maximum cooling and the fan to speed II and "recirculated air."
   b. Place a thermometer in the center vent nozzle and another measuring ambient temperature.
   c. Apply the parking brake, close the vehicle windows and doors and run the engine at 1500 rpm for about three minutes.
   d. Read the temperature on the thermometers. The effect of the ambient temperature on the air temperature leaving the vent nozzle is shown in the temperature comparison table shown on 36-01-12.
4. Compare the manifold gauge readings with the specified values shown below. Then, proceed to the diagnostic tables and match your test results with the test results shown.

Air conditioning operating temperatures on the suction and pressure sides of the compressor.

Test Pressure Ranges

Ambient Temperature		Low-Pressure Side	
°C	°F	kPa	psi
15	60	*60-99	*8.7-14.4
20	68	*60-120	*8.7-17.4
26	79	*60-140	*8.7-20.3
32	90	*60-193	*8.7-28.0
37	100	116-212	16.8-30.8

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* Minimum pressure when clutch is switched on.

Test Pressure Ranges

Ambient Temperature		High-Pressure Side	
°C	°F	kPa	psi
15	60	496-965	72-140
20	68	496-1,158	72-168
26	79	965-1,179	140-171
32	90	1,400-1,738	203-252
37	100	1,593-1,979	231-287

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DIAGNOSIS (Continued)

Temperature Comparison Table (Fan Speed II)

Ambient Temperature		Temperature at Center Vent Nozzle	
°C	°F	°C	°F
15	60	4-6	40-42
20	68	4-6	40-42
26	79	4-7	40-45
32	90	5-8	41-46
37	100	7-10	45-50

NOTE: The preceding tables will be referred to during the A/C diagnosis.

CL5604-A

Complaint—Poor Cooling

Test Results

1. Low-pressure reading too low. See table for correct value.
2. High-pressure reading too low. See table for correct value.
3. Air bubbles in sight glass.
4. Center vent nozzle temperature too high. See table for correct value.

Cause—Insufficient refrigerant in the system caused by a slight leak.

Correction

1. Carry out leak test.
2. Locate and repair any leaks, ensuring that you discharge the air conditioning system first.
3. Evacuate air conditioning system.
4. Recharge air conditioning system.
5. Carry out operational test.

Complaint—No Cooling

Test Results

Compressor clutch will not engage.

Causes

- Electrical fault in the clutch circuit.
- Very little or no refrigerant in the air conditioning system.

Correction

1. Check for faulty fuse.

   Check for loose plug/no contact/broken wire/no ground.

   Check if combination air conditioning/fan switch faulty.

   Check if deice thermostat faulty.

   Check for faulty diode.

   Check for faulty clutch.

   Three-way pressure switch faulty.
2. Disconnect the plug at the compressor clutch. Feed 12 volts directly to the compressor clutch. If the clutch does not engage, replace the clutch assembly. If the clutch does engage, check for an interruption elsewhere in the clutch circuit.
3. Check the level of freon in the system. The engine must be started and the air conditioning system switched on (supplying the clutch with current from an exterior source and bridging the three-way pressure switch). Look for bubbles in the sight glass.

   If bubbles are present continuously after the compressor cuts in, the air conditioning system is considerably underfilled (low-pressure safety switch is stopping the system from working).

   If only a short stream or no bubbles are seen after the compressor cuts in, the level of refrigerant in the system is in order and the three-way pressure switch is faulty.

   NOTE: To carry out the test, run the compressor for no more than 30 seconds; otherwise, the compressor will be damaged by the piston seizing if the system is empty.
4. Discharge the air conditioning system.
5. Replace any faulty parts. Locate and correct any leak. Evacuate and recharge the system.
6. Carry out the operational test.

DIAGNOSIS (Continued)

Complaint—Insufficient Cooling

Test Results

1. Low-pressure reading too low. See table for correct value.
2. High-pressure reading slightly lower. See table for correct value.
3. Air bubbles constantly visible in sight glass.
4. Center vent nozzle temperature too high. See table for correct value.

Cause—Air or insufficient refrigerant in system.

Correction

1. Carry out the leak test, including the compressor.
2. Discharge the air conditioning system.
3. Eliminate the leaks.
4. Replace the receiver/dryer.
5. Evacuate the air conditioning system.
6. Recharge the air conditioning system.
7. Carry out the operational test.

Complaint—Insufficient Cooling

Test Results

1. Low-pressure reading too high. See table for correct value.
2. High-pressure reading too low. See table for correct value.
3. No air visible in sight glass after 5 to 10 seconds.
4. Center vent nozzle temperature too high. See table for correct value.

Cause—Internal leaks in compressor due to faulty valves.

Correction

1. Discharge the air conditioning system.
2. Replace the compressor.
3. Evacuate and recharge the air conditioning system.
4. Carry out operational test.

Complaint—Insufficient Cooling (Sometimes engine overheats)

Test Results

1. Low-pressure reading too high. See table for correct value.
2. High-pressure reading too high. See table for correct value.
3. Air bubbles visible in sight glass from time to time during operation.
4. Line from receiver/dryer to expansion valve very hot.
5. Center vent nozzle temperature too high. See table for correct value.

Causes

Insufficient cooling caused by:

- Auxiliary fan not switching on at pressures above 1,786 kPa (259 psi).
- Surfaces of condenser plates severely damaged (more than 25 percent).
- Condenser plates dirty and so restricting air flow.

Correction

1. Check the mechanical and electrical operation of the auxiliary fan. Possible faults: loose plug, faulty plugs or wiring, relay or motor jammed, fan blades obstructed by foreign bodies. Repair or replace as necessary.
2. Check the electrical operation of the threeway pressure switch. Possible faulty plug or wiring. Repair or replace as necessary.
3. Clean the end of the condenser. If the engine is overheating, check the cooling system (fan, radiator, radiator cap).
4. Carry out the operational test.

Complaint—Insufficient Cooling at High Ambient Temperatures

Test Results

1. Low-pressure reading is normal but a vacuum is indicated during the test.
2. High-pressure reading is normal but falls when a vacuum is indicated on the low-pressure side.
3. Air at center vent nozzle is cold until a vacuum is indicated on the low pressure side; then it gets warm.

Causes—Large amounts of moisture in the system. Drying element in the receiver/dryer is saturated with moisture and is releasing moisture into air conditioning system when outside temperatures are high. This freezes in the expansion valve, blocks it, and prevents refrigerant from flowing to the evaporator.

Correction

1. Discharge the air conditioning system.
2. Replace receiver/dryer.
3. Evacuate air conditioning system.
4. Recharge air conditioning system.
5. Carry out operational test.

DIAGNOSIS (Continued)

Complaint—Insufficient Cooling

Test Results

1. Low-pressure reading too high. See table for correct value.
2. High-pressure either high or normal. See table for correct values.
3. Center vent nozzle temperature too high. See table for correct value.
4. Uneven compressor operation. Compressor vibrating.

Cause—Expansion valve faulty (always open) resulting in excessive delivery of refrigerant to the evaporator (flooding).

Correction

1. Check expansion valve.
   a. Run air conditioning at maximum cooling (fan speed III, "recirculated air," engine at 1500-2000 rpm).
   b. Spray expansion valve sensing tube with refrigerant (aerosol can).
   c. Observe low-pressure reading. Reading should read "vacuum." If not, proceed with Step 2.
2. Discharge the air conditioning system.
3. Replace expansion valve.
4. Evacuate and recharge air conditioning system.
5. Carry out operational test.

Complaint—Insufficient Cooling

Test Results

1. Low-pressure reading too low (below correct value or vacuum). See table for correct value.
2. High-pressure reading normal or too high. See table for correct value.
3. Air at center vent nozzle cool but not cold enough. See table for correct value.
4. Severe condensation or icing on inlet line of expansion valve.

Cause—Expansion valve obstructing flow of refrigerant to evaporator. Expansion valve faulty.

Correction

1. Grasp expansion valve. If it is too cold, proceed as follows:
   a. Run the air conditioning system at maximum cooling.
   b. Spray expansion valve with refrigerant (aerosol can).
   c. Observe low-pressure reading. It must show increased vacuum. If not, proceed with Step 2.
2. Discharge the air conditioning system.
3. Replace expansion valve.
4. Evacuate and recharge air conditioning system.
5. Carry out operational test.

Insufficient Cooling

Test Results

1. Low-pressure reading vacuum. See table for correct value.
2. High-pressure reading too high. See table for correct value.
3. Center vent nozzle temperature too high. See table for correct value.
4. Severe condensation and icing on receiver/dryer and refrigerant line to evaporator.

Causes—High-pressure side of air conditioning system blocked. Constriction/blockage in refrigerant line or in receiver/dryer; evaporator receiving no refrigerant. The compressor is inducing a vacuum.

Correction

1. Discharge the air conditioning system.
2. Replace faulty parts causing blockage in condenser, receiver/dryer, or refrigerant lines between compressor and condenser and evaporator.
3. Evacuate and recharge air conditioning system.
4. Carry out operational test.

Heating System

Engine Operating Temperature

The temperature gauge calibration for the Merkur XR4Ti causes the gauge to respond slowly as the engine temperature rises from cold. It may also cause the gauge to read in the lower end of the normal band when driving at highway speed in low outside ambient temperatures. To correct this, a newly calibrated engine temperature sending unit has been released. The new sending unit (E6RY-10884-B) has a much quicker response from cold and provides greater accuracy throughout the gauge band.

In all cases relating to heater system concerns it is recommended that the vehicle be checked for normal engine operating temperature to assure proper repairs are performed. To do so, start with a cold engine and the coolant reservoir cap removed. Place a digital probe or dial-type thermometer in the reservoir and start the engine. When the temperature reading starts to rise, with a bare hand, feel the upper radiator hose a few inches back from the thermostat housing. The hose should remain cold until the temperature reading in the reservoir reaches approximately 165°F (74°C).

At this point the engine coolant at the thermostat will be 192°F (89°C), the thermostat should open and the radiator hose should rapidly become hot to the touch and then begin to cool slightly as the coolant flows through the radiator. Thereafter, with the engine RPM increased to 1500-1800, the hose heat can be felt alternately changing as the thermostat opens and closes.

DIAGNOSIS (Continued)

If the temperature reading is very slow in rising and the upper radiator hose gradually warms at the same time (before the temperature in the coolant reservoir reaches 165°F, 74°C), the thermostat should be serviced before proceeding further. Refer to Section 27-01 for removal and testing procedures.

NOTE: Vehicles built prior to June 2, 1986 were equipped with a thermostat that may not have been properly seated in the housing during assembly of the engine. These thermostats may not fully close and often may stick fully open. Generally these vehicles will not reach normal operating temperatures and there will be insufficient heat, particularly when driving at highway speeds. This concern was corrected in production with a new design thermostat which is also released for service. The part number is E6FZ-8575-A (RT-1055).

Heater Control Servo Switch

All vehicles built prior to July 10, 1986 and subjected to high interior temperatures during summer months may have a servo switch that will stick in the cold position. This servo switch is attached to the heater/A/C temperature control lever in the control assembly and controls the vacuum supply to the heater water valve in the engine compartment. When the switch is stuck there will be full vacuum to the water valve and as a result, cold air from the heater. To check the operation of this switch, place the temperature control in the full warm (red) position and disconnect the vacuum hose from the top of the water valve. With the hose disconnected there should be no vacuum at the hose and maximum heat from the heater. If vacuum is found at the hose the switch is not operating correctly. If the switch is not operating correctly, replace it with a new switch (E7RY-18C311-A). The switch can be accessed by removing the instrument panel cluster assembly. If necessary, refer to Section 33-50.

NOTE: Because the servo switch plunger is spring loaded, this problem is often intermittent in nature. It usually occurs when the temperature lever has been positioned to the lowest (blue) position and then moved up to the red area.

Heater Water Valve

To check the heater water valve, bring the engine to normal operating temperature. Place the temperature control lever in the full cold (lowest) position and activate the blower motor. The air flow from the heater should be cold. Place the temperature lever to full hot (highest) position. The air flow should now be maximum warm (approximately 140°F, 60°C, or higher). If the air is still cold or significantly below 140°F (60°C), remove the vacuum hose from the top of the water valve and recheck the air flow. If there is no change replace the water valve (E5RY-18495-A).

Heater Core

All vehicles built prior to May 19, 1986 were equipped with a normal duty heater core which may not produce adequate heat when outside temperatures are extremely low. Vehicles built after this date are equipped with a heavy duty core which increases the heat output by 12 to 15 degrees. Service part heater cores (E5RY-18476-A) were also upgraded at this time.

Temperature Guidelines

The following temperatures are measured at the center instrument panel register, outside air mode and on the number "2" blower position. Field readings will vary somewhat depending on the type of thermometer used and outside temperatures.

- Idle—warm engine, 140°F (60°C).
- Idle—hot engine, 150°F (65°C).
- Highway speed—outside temperature 32°F (0°C), 152°F to 150°F (67°C to 65°C).

Water Leaks

Some Merkur XR4Ti vehicles may have water leaking into the passenger compartment at the front footwell and tunnel area.

There are two primary sources for this water entry and in some cases more than one source may be applicable, particularly when prior service attempts have been unsuccessful. The two sources are condensation from the air conditioning system and outside water from rain or car washing. In both cases the water will be seen dripping at exactly the same area. The only exception to this is when the fuse box cover is loose or missing, in which case external water will wick through the wire harness and drip in the left footwell above the brake pedal. Whenever external water is suspected, proper installation of the fuse box cover should be checked first.

Before beginning the diagnosis, it should be understood that a water leak from condensation is the result of a nonfunctioning evaporator housing drain system. External water entering is the result of improper evaporator housing sealing. In both cases the water enters the vehicle through the same opening in the body, but from different causes. For this reason, all three of the following tests and applicable repairs should be conducted on concern vehicles in the order they are shown.

DIAGNOSIS (Continued)

Test #1—Duct Hoses

A disconnected or missing air duct hose, especially the center register hose, decreases blower motor resistance and increases the blower motor speed. The increased speed creates a vacuum at the evaporator fresh air inlet which can draw rain water into the air distribution system. It then collects in the heater housing and leaks on the tunnel area.

To check for this condition, place the air distribution lever in the "panel" position and close all instrument panel vents. Turn the blower switch to low speed in the outside air mode and open each vent individually and check for air flow. If no air flow is detected in one or more of the vents, refer to Section 36-01 to connect the duct or ducts as required.

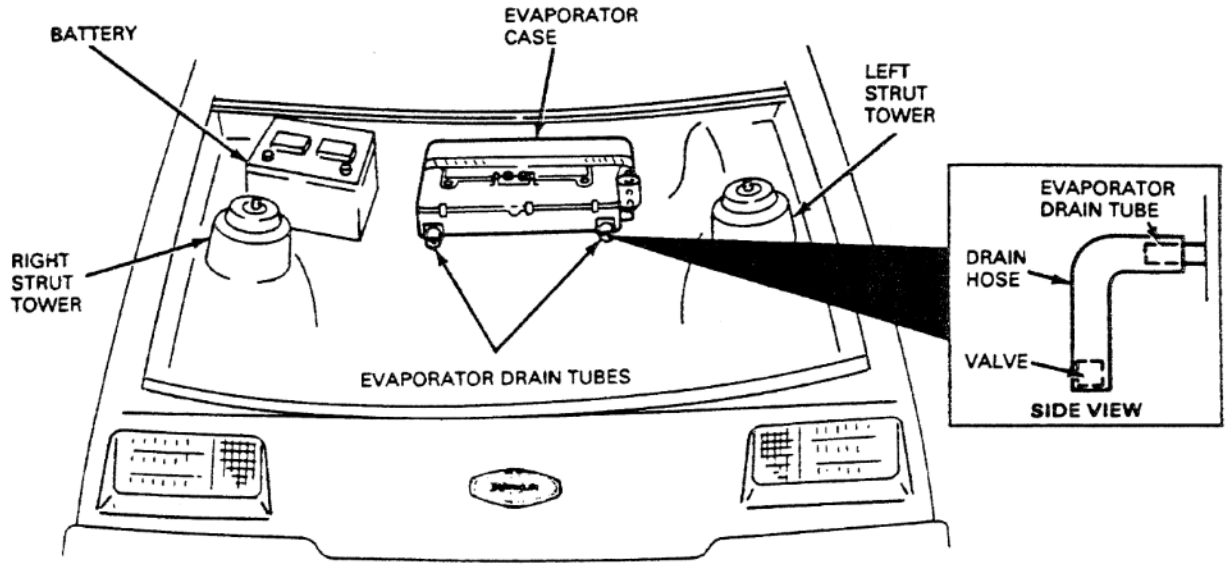
NOTE: If it is determined that the center duct is not connected, do not attempt to connect it by removing the center register. The center register can only be reinstalled by removing the instrument panel from the vehicle.

Test #2—Water From Condensation

The evaporator housing drain system works on the principal of a balance of gravity and internal vacuum pressure. Any fault with the system or components will result in water being drawn to the blower motor and forced into the air distribution system rather than into the drain hoses.

1. To check for this condition, operate the air conditioning system on maximum cold for approximately thirty minutes (or less depending on humidity). If water is observed dripping on the tunnel area, turn the system off and check the drain hose and check valve assemblies. The hoses protrude into the engine compartment on either side of the engine as shown. The hoses are a slip fit on the evaporator drain tubes. When removing, note the side (right and left) for proper reinstallation. The hoses and valves must be clean and free of foreign material. The check valve rubber flap must face outward, be snug but have just enough clearance at the center pin to allow it to be freely rotated. It cannot have any holes or gaps at the outer edges. If a fault is detected, clean or replace the hose assemblies as needed and retest the system.

   NOTE: The check valve and hose are serviced as an assembly (E5RY-19858-A/C).



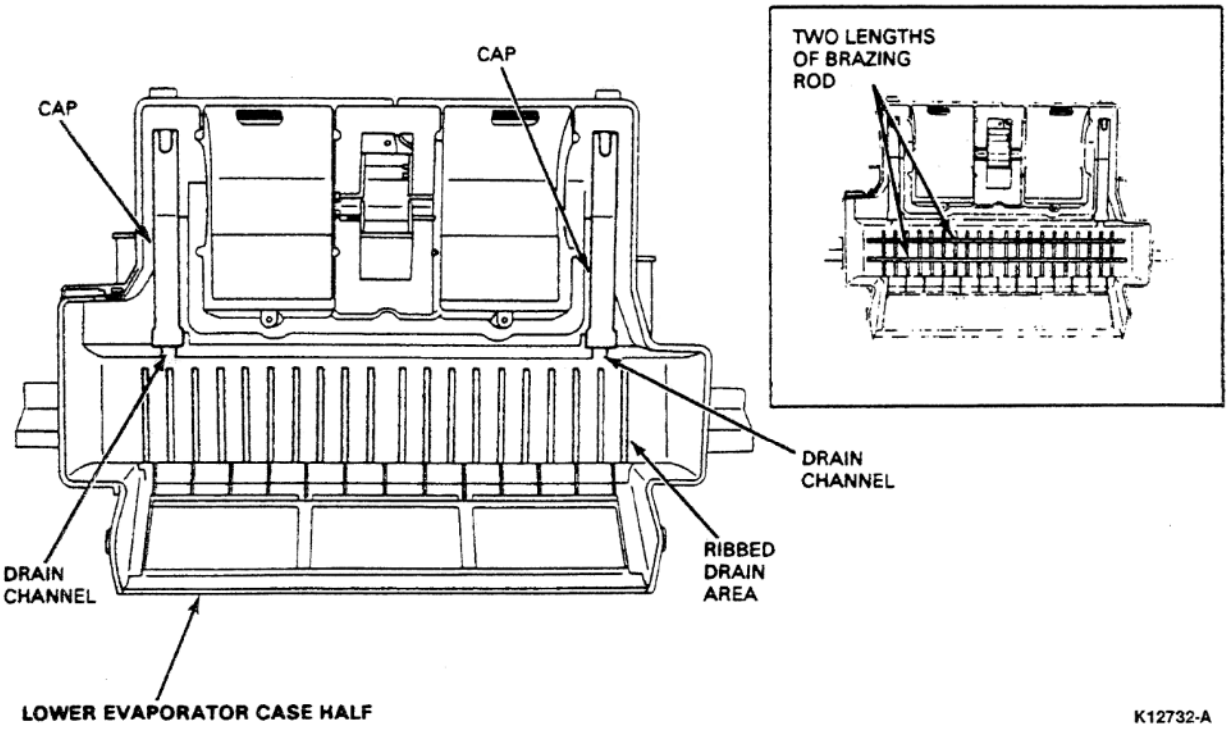
K12731-A

DIAGNOSIS (Continued)

2. If no fault was detected in the drain hose assemblies and/or if condensation water is still dripping into the interior of the vehicle, remove the evaporator assembly from the vehicle. If necessary, refer to the procedure in this Section. Remove the upper case half and inspect it for warpage or damage and replace it if necessary. Also, inspect the lower case half. The ribbed drain area beneath the evaporator core and the drain channels leading to the hoses must be open and clean.

   The plastic covers over the drain channels must be tight to the case body. On some vehicles these covers have been found to be loose and/or warped. When this occurs, blower motor vacuum draws the water out of the channels and into the heater ducts. If this condition is found, secure the covers with a suitable plastic cement and a light bead of butyl sealer. Use caution not to block the channels.

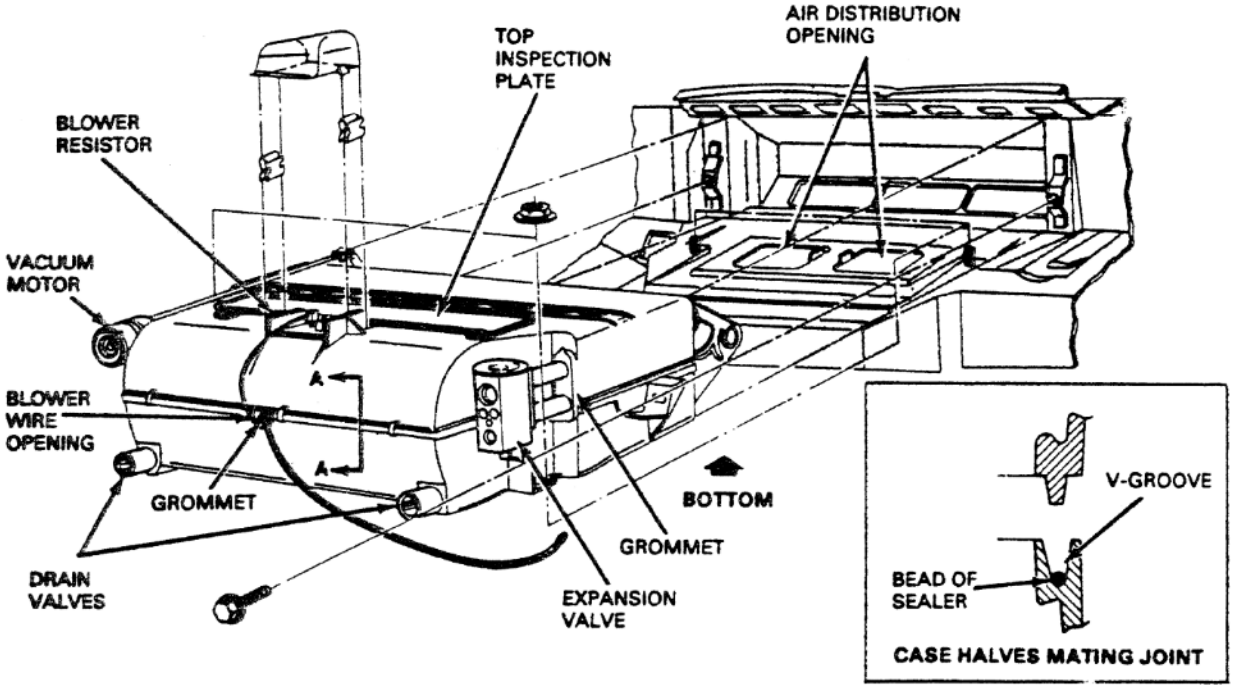
3. In a few cases a combination of tolerance stackup and slight warpage of the lower case half may have decreased the clearance between the case bottom and the evaporator core. This restricts the air flow that normally pushes water into the drain channels and allows some water to flow back towards the blower motor. To correct this condition, shim the evaporator core up from the case bottom 1/8 inch (4mm) as shown. Use a suitable material compatible with aluminum placed across the case bottom ribbed area. An example would be two lengths of brazing rod. Do not use steel or wood. It is recommended this step be done on all concern vehicles whenever the housing is being serviced.



DIAGNOSIS (Continued)

4. When assembling the case halves, apply a bead of sealer in the 'V' groove of the mating joint and the opening for the blower wires as shown. Before installing the assembly in the vehicle, inspect the plenum seal at the recirc door and replace it if it is damaged (E5RY-18B623-B). The lower gasket between the housing and air distribution opening (E5RY-18583-A) must be replaced. This is a compressed seal gasket that remains compressed after use and is likely to leak if reused. Install the evaporator assembly. If necessary, refer to the procedure in this Section.

CAUTION. When reinstalling the evaporator assembly the lower gasket may catch on the mating surface and not seat properly.



Test #3—External Water Entry

1. With the exception of a loose fuse box cover as previously noted, external water can enter the evaporator housing in several places but entry into the interior of the vehicle is always through the air distribution opening in the body beneath the blower motor as shown above. To facilitate water testing, remove the plastic insulator cover at the cowl to expose the evaporator assembly to water flow.

   Set the air distribution lever on the "floor" position and activate the blower motor on high speed. Direct a liberal flow of water across the windshield in a manner that allows water to flow over the center cowl area and the evaporator housing. It should be noted that water entering the vehicle is first absorbed by the foam rubber gaskets at the heater housing and does not start to drip until the gasket is saturated. Therefore, a minimal leak may not be observed until approximately thirty minutes of continuous water flow after starting the test.

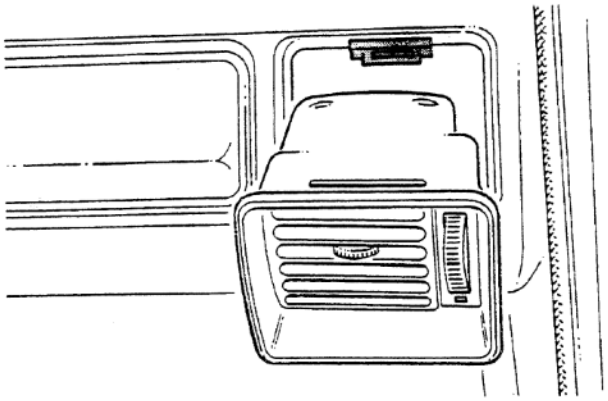
2. If water is observed entering the vehicle, first check to ensure the blower resistor, the top inspection plate, grommets and the blower wire opening as shown above, are secure and sealed. If a fault is found with these items, repair/seal as necessary and retest. If no fault is found or if water entry is still present, the evaporator assembly must be removed if not already done during the previous test. Reseal the upper case half at the "V" groove and replace the gaskets as outlined in the previous test.

REMOVAL AND INSTALLATION

Right Air Vent

Removal and Installation

1. Disconnect the battery ground cable.
2. Remove the center console and shift it toward the rear.
3. Remove the cowl side trim panel in the right-hand footwell.
4. Pull off the combination fan/air conditioning rotary switch knob and bezel. Remove the lower right-hand dash panel. Disconnect the glove compartment light, fan switch, cigar lighter, heated seat switch, and radio connectors.
5. Detach hose from vent nozzle. Press top and bottom spring retainers out of the retaining slots using a screwdriver and remove the nozzle.
6. To install, reverse Steps 1 through 5.

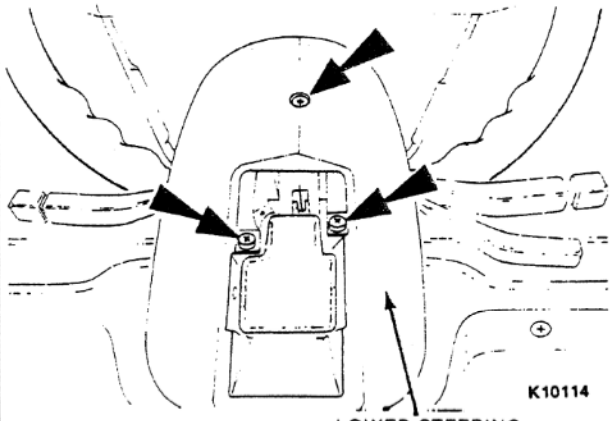


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Left Air Vent

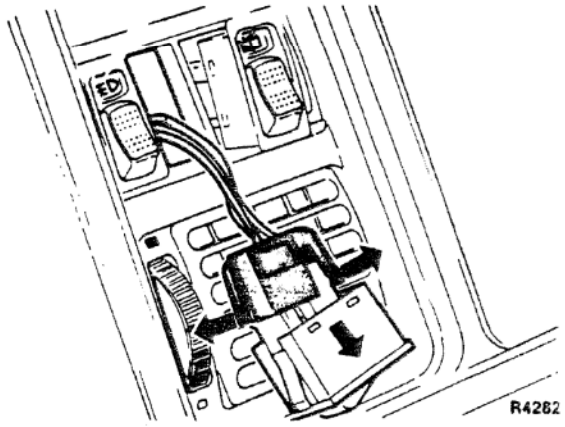
Removal and Installation

1. Disconnect the battery ground cable.
2. Remove lower steering column shroud.



3. Remove left-side cowl trim panel.
4. Remove left-hand lower dash panel (five screws).
5. Detach hose from vent nozzle.
6. Remove rocker switches toward the front and disconnect harness connectors.
7. Remove vent nozzle and mounting.

   NOTE: The left-hand vent nozzle is secured by two screws at the top and held by a clip at the bottom.
8. To install, reverse Steps 1 through 7.

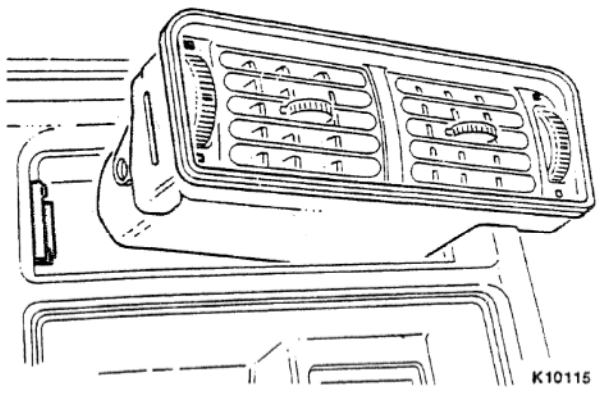


R4282

Center Vent

Removal

1. Disconnect the battery ground cable.
2. Remove the center console and shift it toward the rear.
3. Remove the right-hand cowl trim panel.
4. Remove right-hand lower dash panel (eight screws). Pull off combination fan-A/C rotary switch knob. Disconnect glove compartment light, fan switch, cigar lighter, heated seat switch and radio connectors.
5. Detach air hose from vent nozzle. Pry the spring retainers out of the retaining slots on the right- and left-hand sides using a screwdriver. Remove the center vent.



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REMOVAL AND INSTALLATION (Continued)

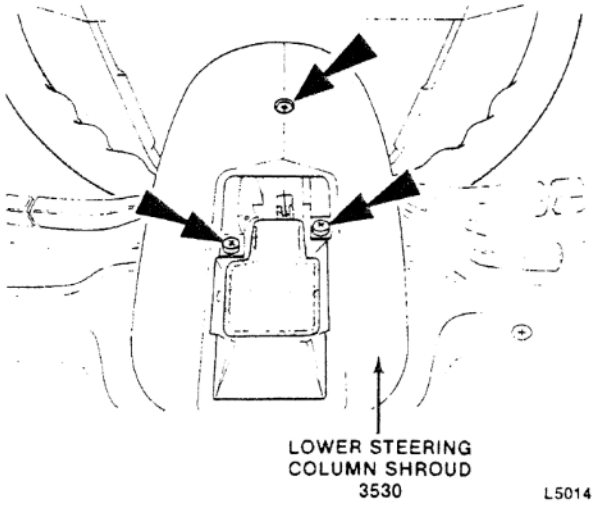
Installation

1. Insert vent nozzle into aperture by pressing its retaining clips into the retaining slots. Fit hose.
2. Reconnect fan switch, cigar lighter, glove compartment light, heated seat switch and radio connectors. Secure lower dash panel with eight screws. Reinstall fan-A/C rotary switch knob.
3. Install right-hand cowl side trim panel with two screws.
4. Shift the center console forward and tighten its retaining screws.
5. Reconnect the battery ground cable.

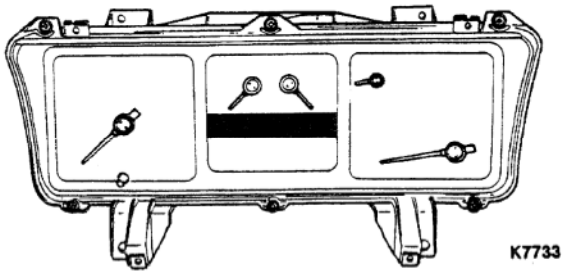
Control Assembly

Removal

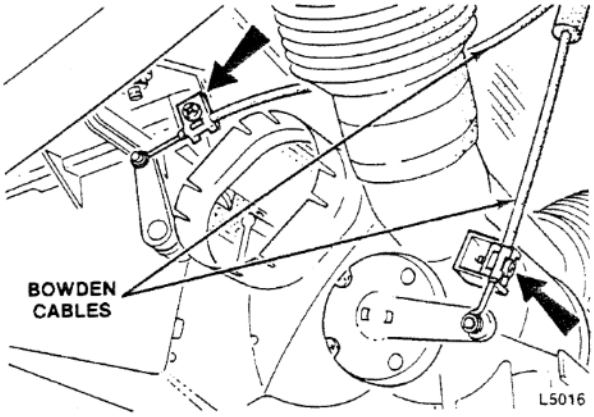
1. Disconnect battery ground cable.
2. Remove upper and lower steering column shrouds.



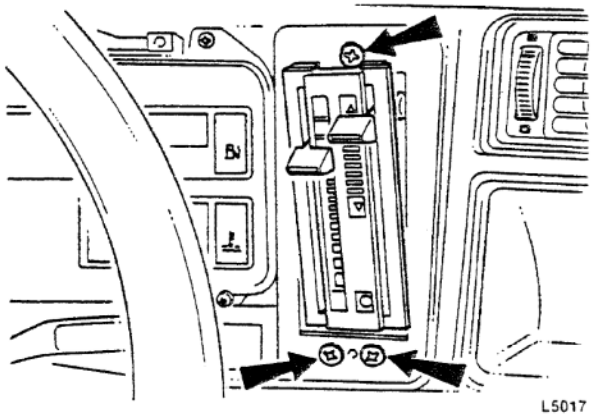
3. Remove instrument cluster bezel and instrument cluster. Refer to Section 33-50.



4. Remove the center console screws and position it toward the rear.
5. Remove left-hand side cowl trim panel.
6. Pull off combination rotary air conditioning/fan switch and bezel. Disconnect glove compartment light and cigar lighter. Remove left-hand lower dash panel. Remove the passenger side lower instrument panel. Refer to Section 45-61.
7. Remove the two bowden cables at the bottom of the heater.



8. Pull the hoses off the vacuum valve and remove the three control unit screws. Push the control unit through and pull it downwards to remove. Remove the bulb and bulbholder.



REMOVAL AND INSTALLATION (Continued)

Installation

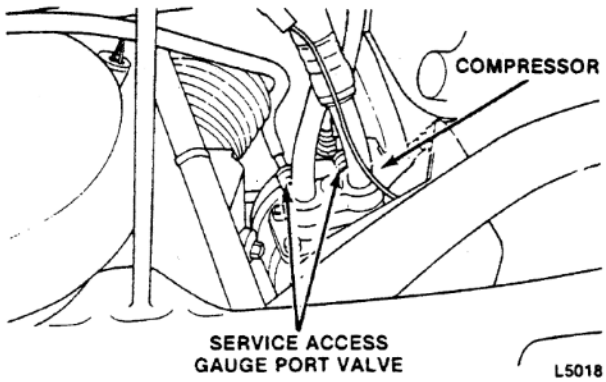
1. Reconnect the hose to the vacuum valve. Insert bulb and holder in control unit and retain the control unit in place with three screws.
2. Set control levers in "up" position, attach cables and secure sheathing.

   NOTE: The bowden cables are adjusted at the control unit. Attach the bottom ends of the bowden cables to the heater. Set the control levers in the "up" position, attach the cables to the control unit and clamp the outer sheathing.
3. Reinstall left-hand lower dash panel and passenger-side lower instrument panel. Connect fan switch, cigar lighter, and glove compartment light. Reinstall bezel and combination rotary air conditioning/fan switch.
4. Install side trim panel to left-hand footwell.
5. Install center console.
6. Install instrument cluster bezel and instrument cluster. Refer to Section 33-50.
7. Install upper and lower steering column shrouds.
8. Reconnect battery ground terminal.

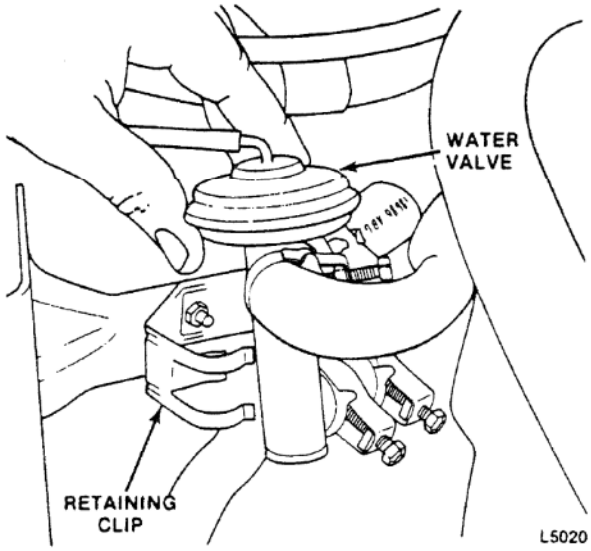
Evaporator Case

Removal and Installation

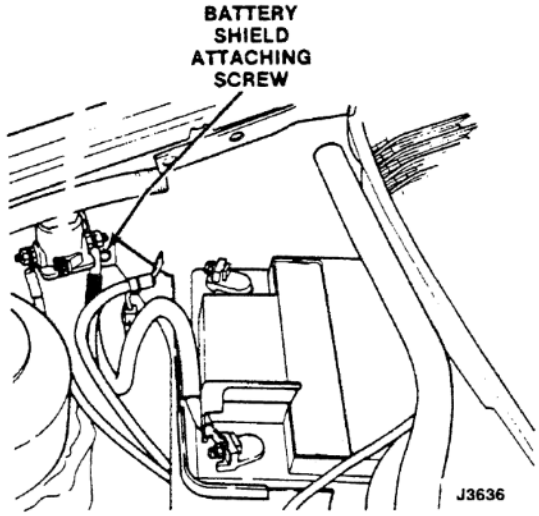
1. Disconnect both the positive and negative battery cables.
2. Discharge the refrigerant from the A/C system at the service access gauge port valve. Observe all safety measures.



3. Remove the engine valve cover. Refer to Section 21-05.
4. Remove the cowl insulator cover.
5. Pull water valve out of its retaining clip. Remove the retaining clip.

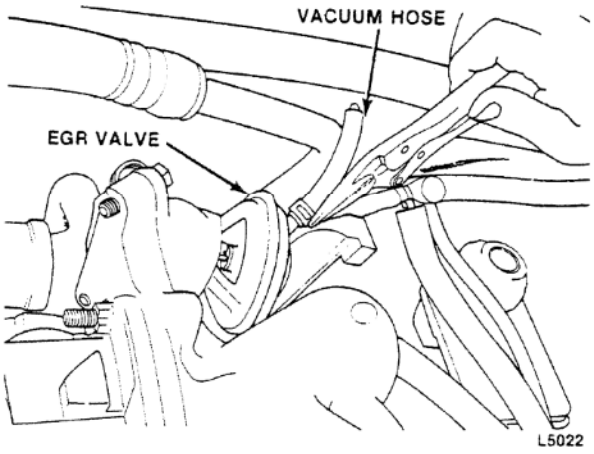


6. Remove the battery shield by removing the two battery shield attaching screws.

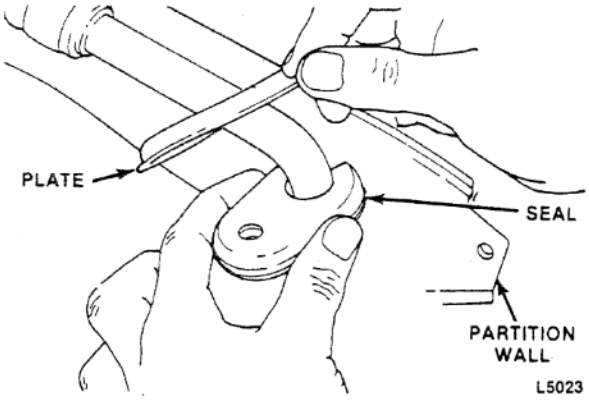


REMOVAL AND INSTALLATION (Continued)

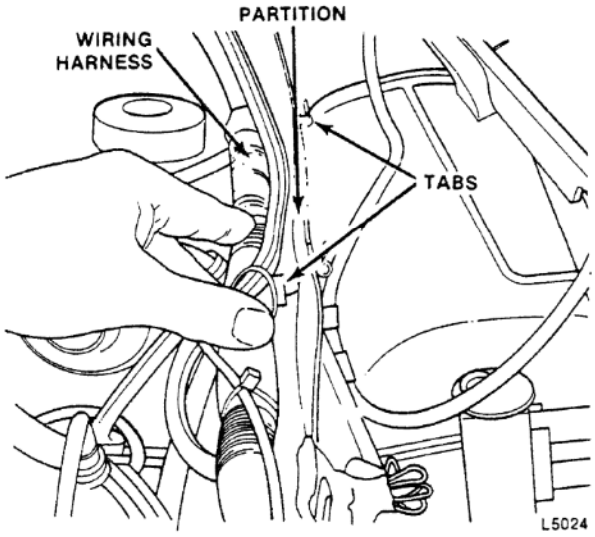
7. Disconnect the vacuum hose from the EGR valve. Disconnect the EGR valve by removing the bolts attaching it to the manifold and move it forward to provide clearance.



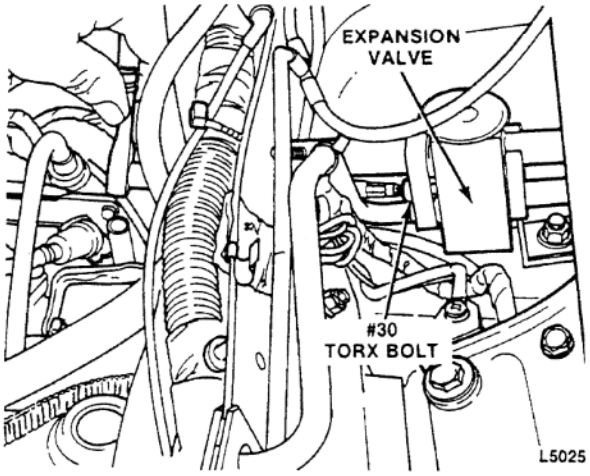
8. Remove the two nuts retaining the air conditioning hose plate and seal at the partition between the engine compartment and evaporator. Remove the plate and seal.



9. Disconnect the wiring harness from the partition. (Pull the harness forward to disconnect the tabs connecting the harness to the partition.)

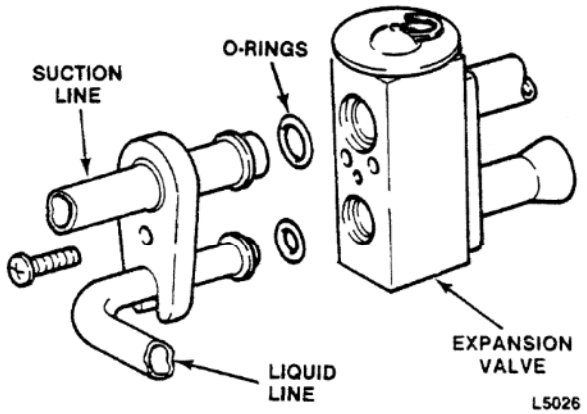


10. Remove the No. 30 Torx® bolt retaining the refrigerant lines to the expansion valve.



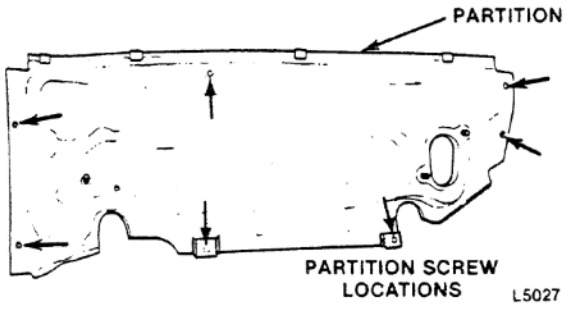
REMOVAL AND INSTALLATION (Continued)

11. Disconnect the suction line and liquid lines at the expansion valve.

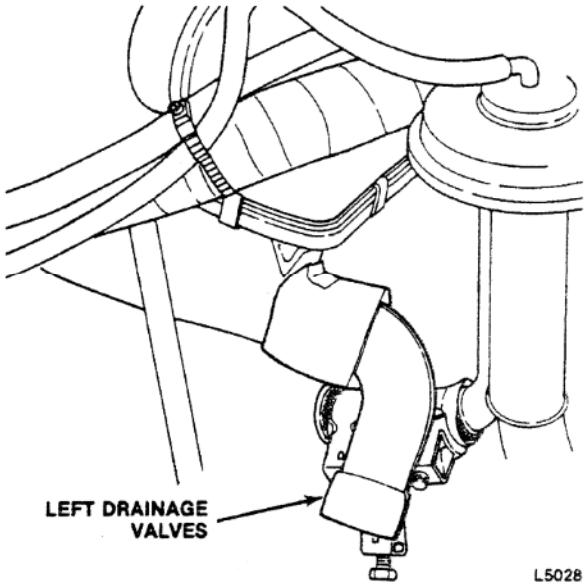


12. Remove the weather seal from the upper edge of the partition.
13. Remove the seven screws retaining the partition. See illustration for location of screws in reference to the partition.

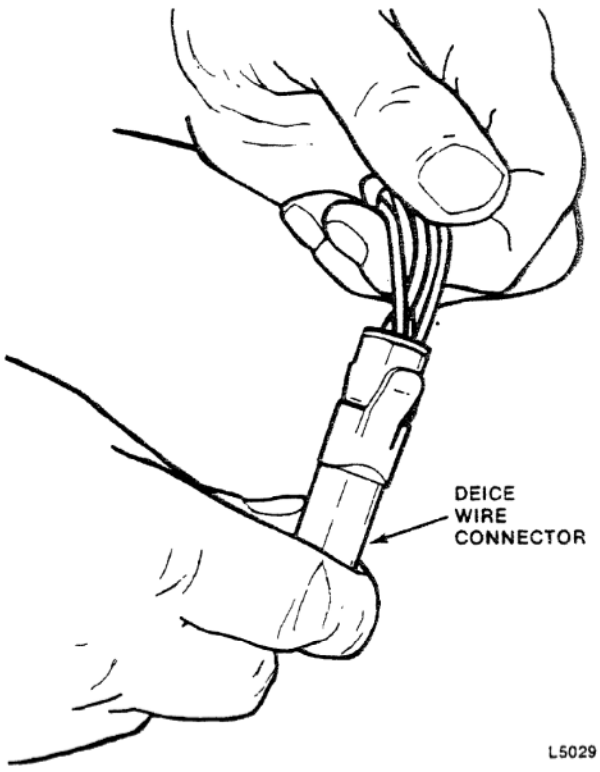
    NOTE: If the screws are damaged on removal, replace the retaining screws with 10mm hex head screws and washers.



14. Remove right and left drainage valves.
15. Remove the partition by pulling it up and out.

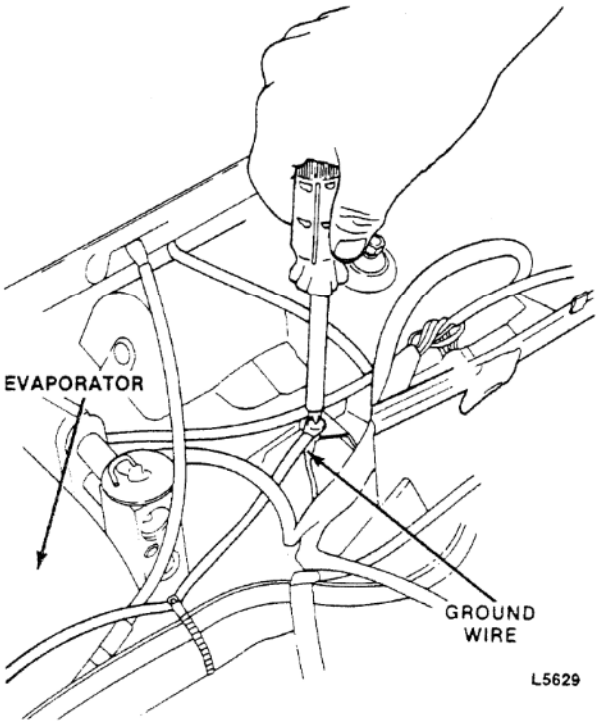


16. Disconnect the deicer wire at the connector.

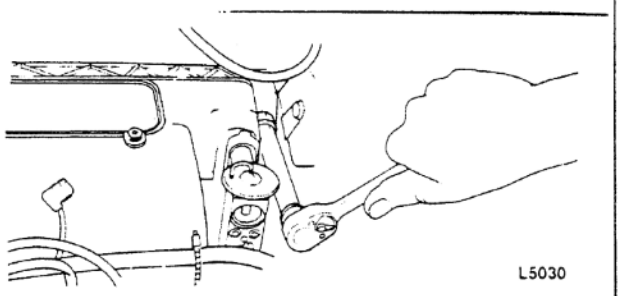


REMOVAL AND INSTALLATION (Continued)

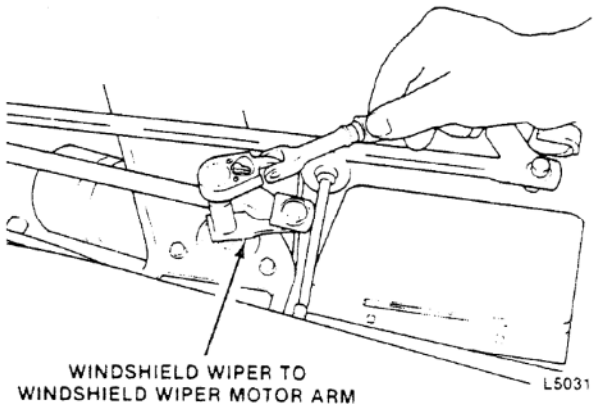
17. Disconnect the ground wire on the evaporator.



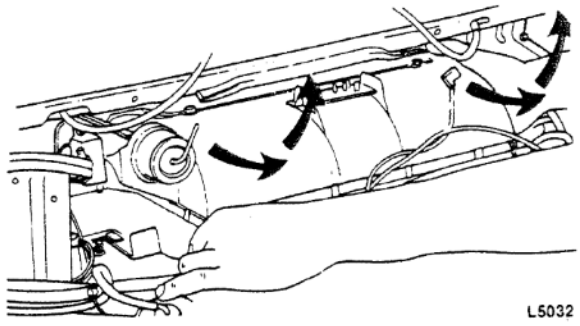
18. Disconnect the evaporator to dash panel attaching bolts.



19. Remove the cowl grille panel. Disconnect the windshield wiper to windshield wiper motor arm to provide access for removing the evaporator.



20. Slide evaporator case assembly upward and forward out of engine compartment. Check and replace seals if damaged.
21. To install the evaporator, reverse Steps 1 through 20.

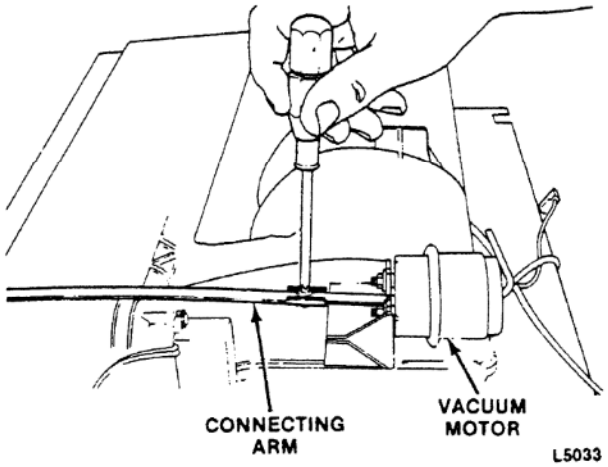


REMOVAL AND INSTALLATION (Continued)

Evaporator Vacuum Motor

Removal and Installation

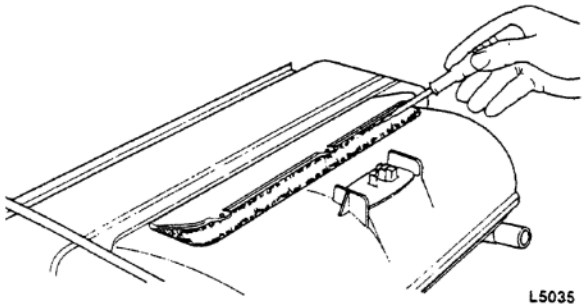
1. Remove the vacuum motor from the connecting arm by removing the connecting screw.
2. To install, reverse Step 1.



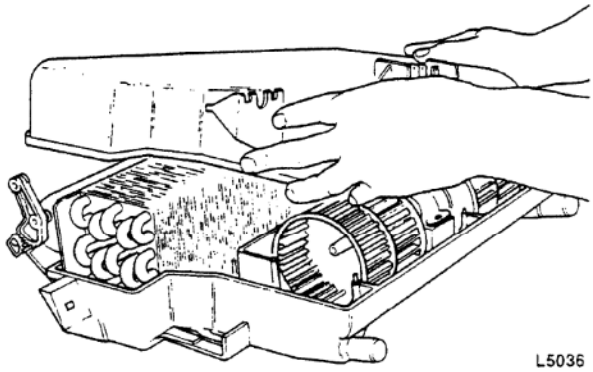
Evaporator Core and Blower Motor

Removal and Installation

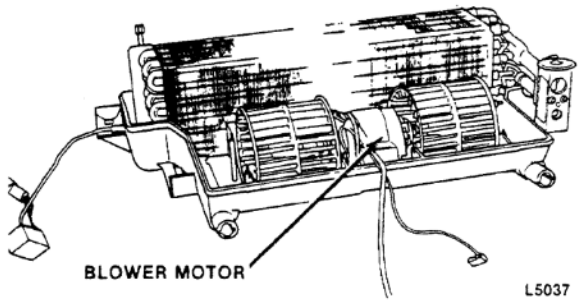
1. Remove the evaporator case using the evaporator case removal procedure.
2. Remove the three access cover retaining screws. Pry the cover open using a screwdriver.
3. Remove the two screws on the blower scrolls to the lower case and the two screws attaching the deice thermostat.



4. Separate the evaporator case halves by removing the connecting clips sealing the case.



5. Remove the one screw retaining the blower motor to the case as required. Remove the evaporator core and/or blower motor as required.
6. To install the evaporator core and/or blower motor, reverse Steps 1 through 5. Be careful to correctly align the deice thermostat sensor during installation.

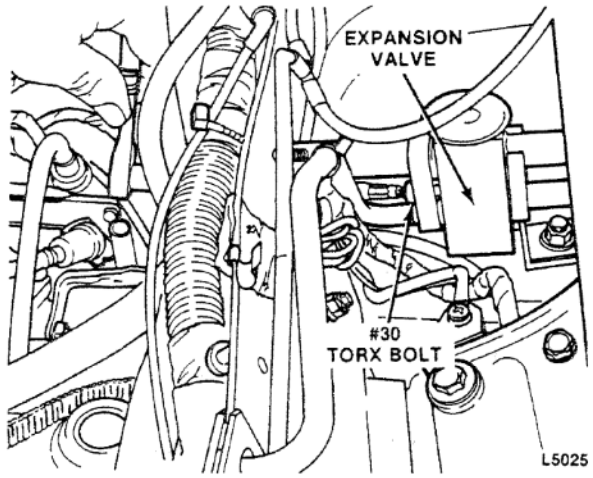


REMOVAL AND INSTALLATION (Continued)

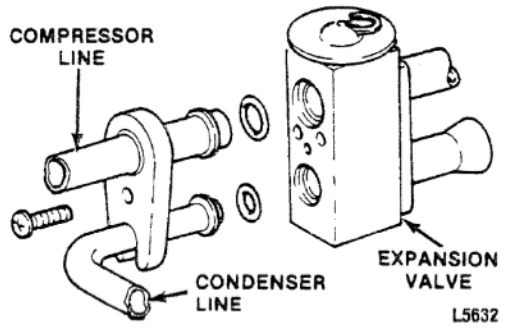
Expansion Valve

Removal and Installation

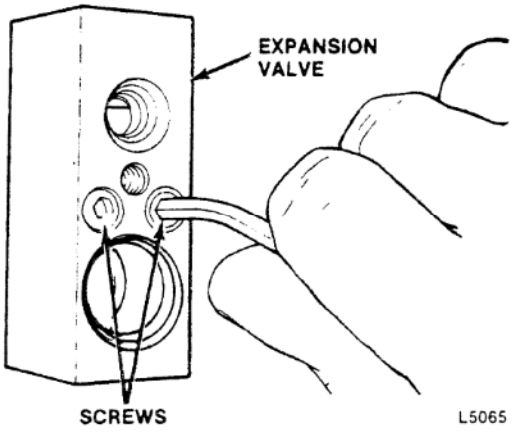
1. Disconnect both the positive and negative battery cables.
2. Discharge the A/C system. Follow approved safety precautions.
3. Remove the engine valve cover.
4. Remove the cowl insulator cover.
5. Disconnect the vacuum hose from the EGR valve. Disconnect the EGR valve by removing the bolts attaching it to the manifold and move it forward to provide clearance.
6. Remove the two nuts retaining the two refrigerant line seals on the partition between the engine compartment and evaporator.
7. Remove the No. 30 Torx® bolt retaining the refrigerant lines to the expansion valve.



8. Disconnect the compressor to suction and liquid lines at the expansion valve.



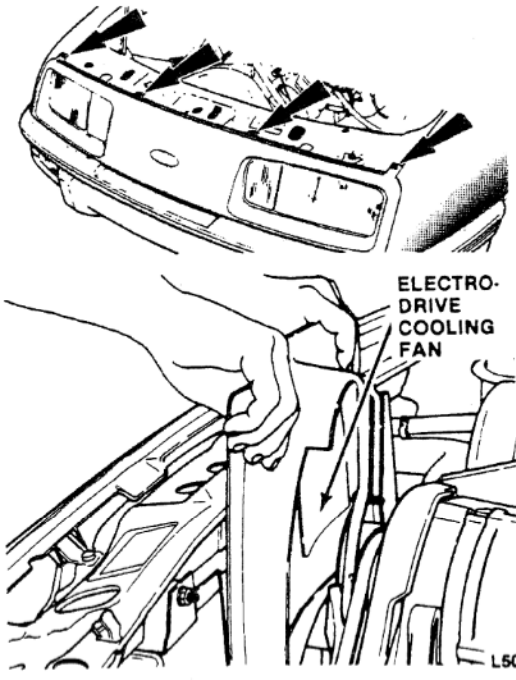
9. Remove the two screws holding the expansion valve to the evaporator. Remove the expansion valve.
10. To install, reverse Steps 1 through 9. Replace the O-rings on the expansion valve.



Condenser

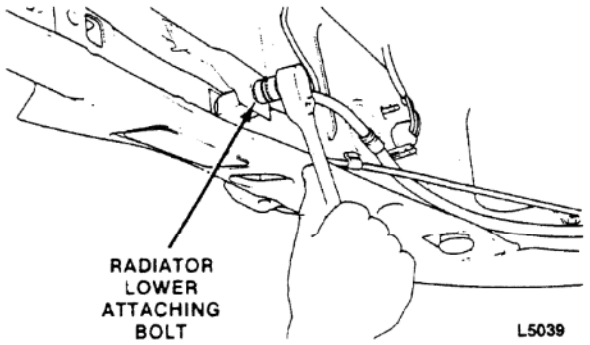
Removal and Installation

1. Disconnect the negative battery cable.
2. Discharge the A/C system. Follow all safety procedures.
3. Remove the grille opening panel (g.o.p.).
4. Drain the radiator.
5. Disconnect attaching screws and remove the electro-drive cooling fan by raising it straight up through the engine compartment.

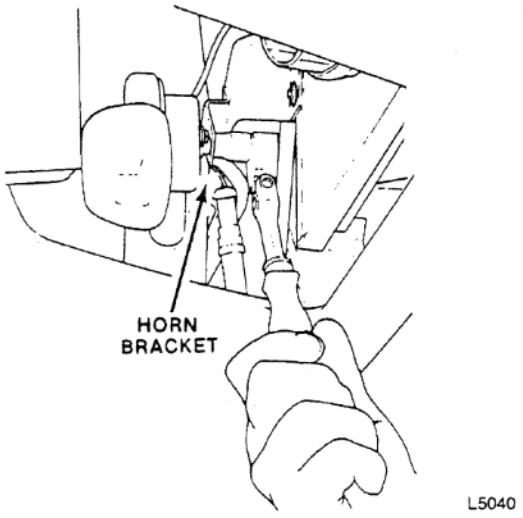


REMOVAL AND INSTALLATION (Continued)

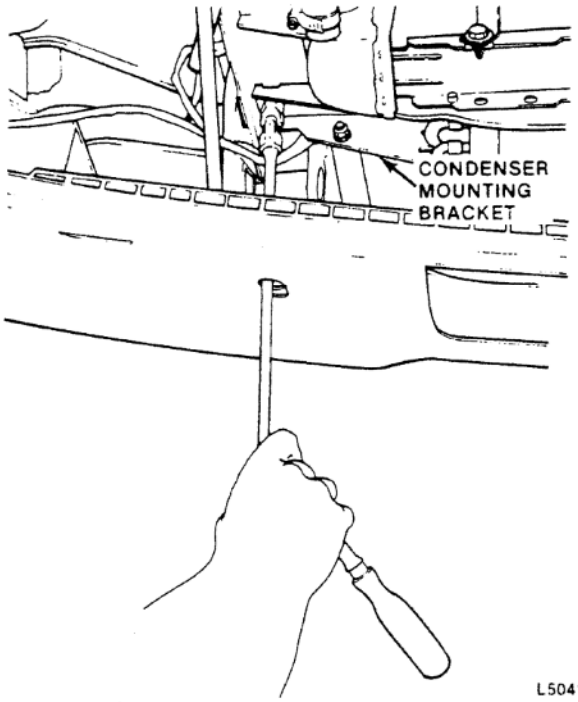
6. Raise the vehicle. Remove the radiator lower attaching bolts.



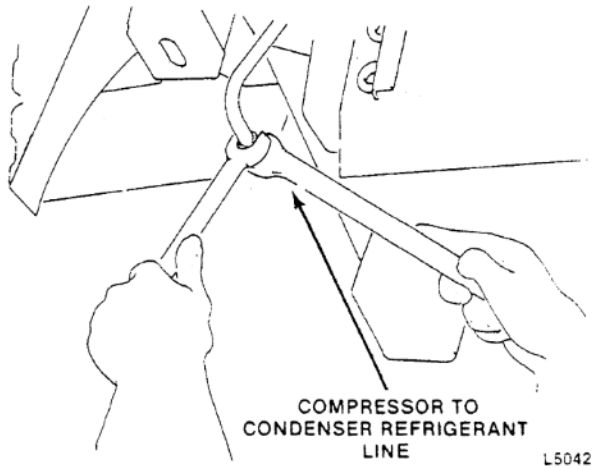
7. Remove the bolts retaining the right and left horn brackets and position the horns out of the way.



8. Remove the bolts retaining the condenser mounting brackets.

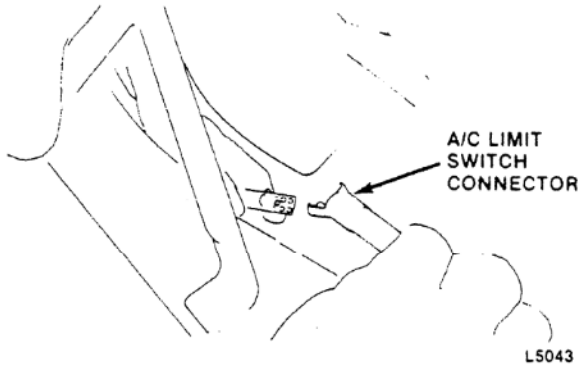


9. Disconnect the compressor to condenser refrigerant line. Cap the lines.

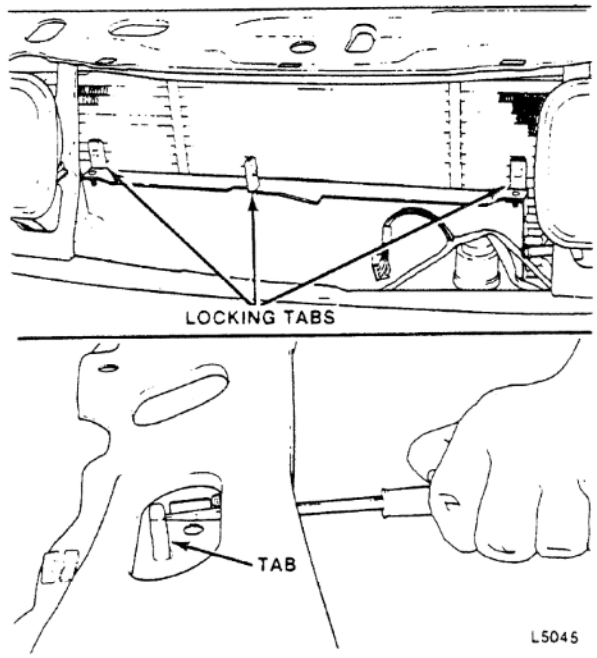


REMOVAL AND INSTALLATION (Continued)

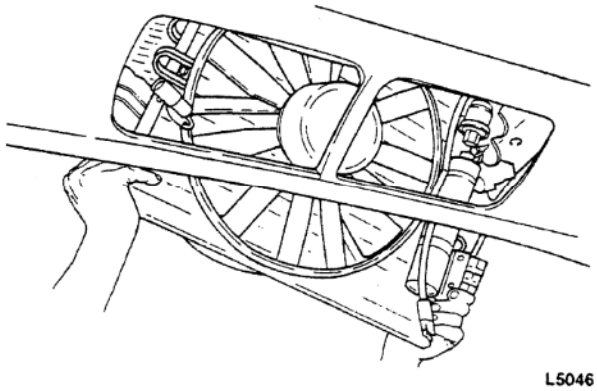
10. Disconnect the A/C limit switch on the receiver/dryer lead at the connector.



11. Disconnect the two lines from the receiver/dryer (the upper line is to the expansion valve; the lower line is to the condenser).
12. Going through the opening in the radiator support, push forward on the plastic of the two outer tabs to release the condenser.
13. Disconnect the front fan lead at the connector.



14. Swing the radiator toward the engine compartment. Lower the A/C fan, condenser and receiver/dryer assembly through the accessed opening.
15. To install, reverse Steps 1 through 14.

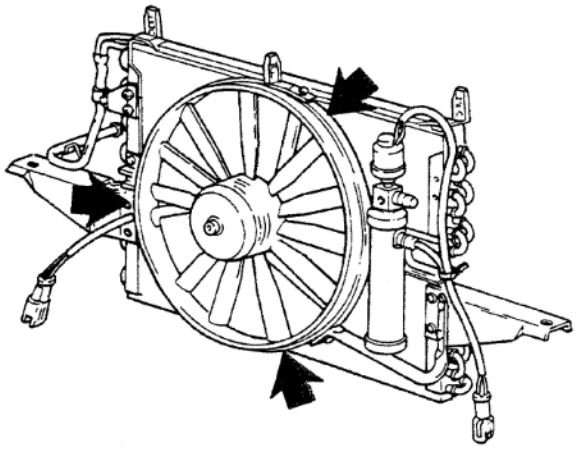


NOTE: 1985 shown, 1986 similar

A/C Fan

Removal and Installation

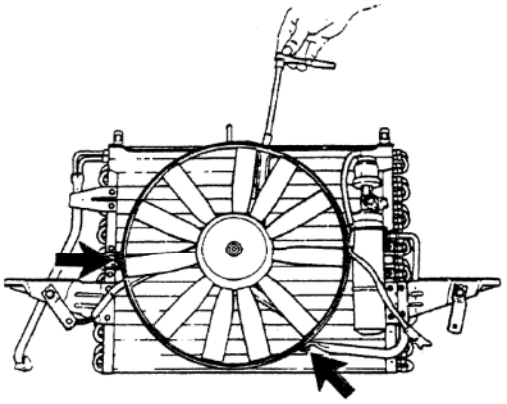
1. Remove the fan and condenser assembly as detailed above.
2. Place the condenser on a flat surface. Mark the fan to assure the best alignment of the electrical lead during installation.



NOTE: 1985 shown, 1986 similar

REMOVAL AND INSTALLATION (Continued)

3. Remove the three fan attaching bolts and remove the fan.
4. To install, reverse Steps 1 through 3.



L5048

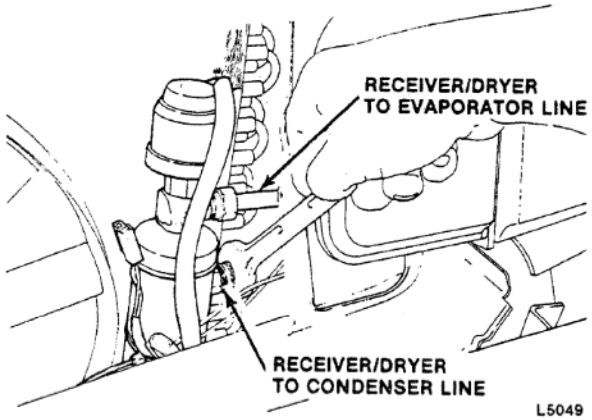
NOTE: 1985 shown, 1986 similar

Removal and Installation

NOTE: The receiver/dryer can be removed either on-car or off-car. If the receiver/dryer is to be replaced, do not remove the protective caps from the replacement receiver/dryer until it is ready to be installed to prevent condensation from entering the system.

On-Car

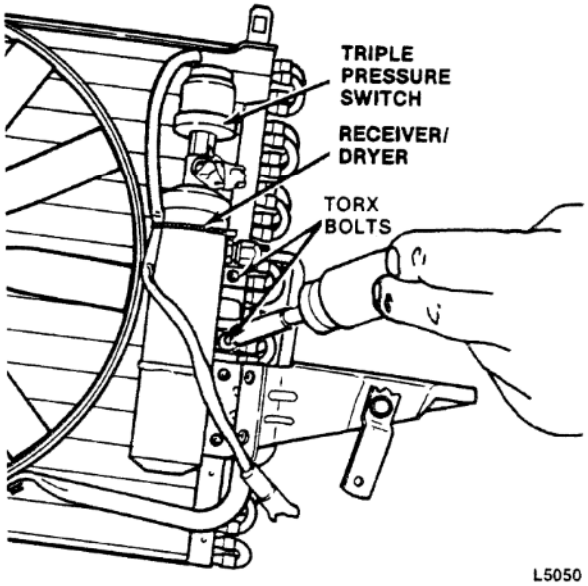
1. Disconnect the negative battery cable.
2. Remove the grille opening panel.
3. Discharge the A/C system. Follow all safety procedures.
4. Disconnect the receiver/dryer to condenser refrigerant line and the receiver/dryer to evaporator line. Cap the lines.



L5049

NOTE: 1985 shown, 1986 similar

5. Remove the Torx® head bolts attaching the receiver/dryer to condenser. Remove the condenser.
6. To install, reverse Steps 1 through 5.



L5050

NOTE: 1985 shown, 1986 similar

Off-Car

1. Remove the A/C fan and condenser assembly as detailed in the condenser removal procedure in this Section.
2. Remove the Torx® head bolts attaching the receiver/dryer to condenser. Remove the receiver/dryer.
3. To install, reverse Steps 1 and 2.

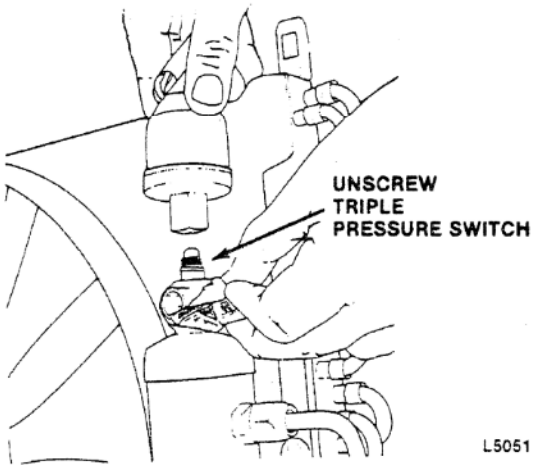
REMOVAL AND INSTALLATION (Continued)

Triple Pressure Switch

Removal and Installation

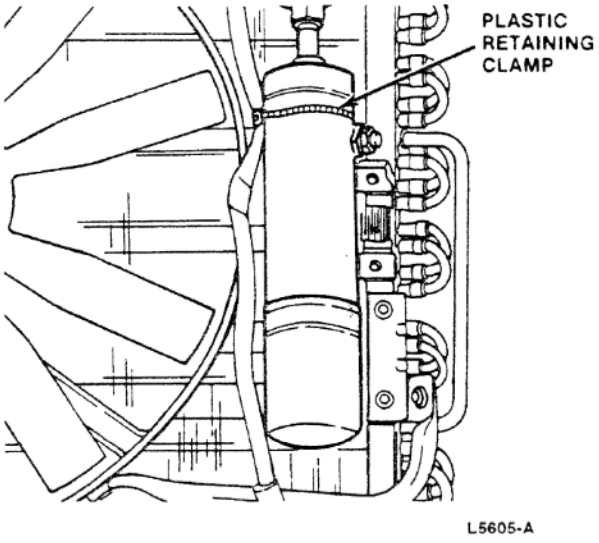
NOTE: This procedure can be done on-car or off-car.

1. Disconnect the negative battery cable.
2. Remove the triple pressure switch from the receiver/dryer.



NOTE: 1985 shown, 1986 similar

3. Cut the plastic retaining clamps holding the pressure switch line to the receiver/dryer and remove the triple pressure switch.
4. To install, thread the cycling pressure switch into the receiver/dryer finger tight and install a new plastic retaining clamp.

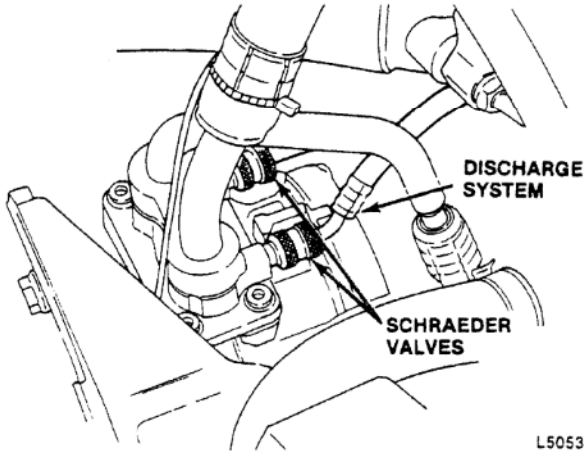


NOTE 1985 shown, 1986 similar

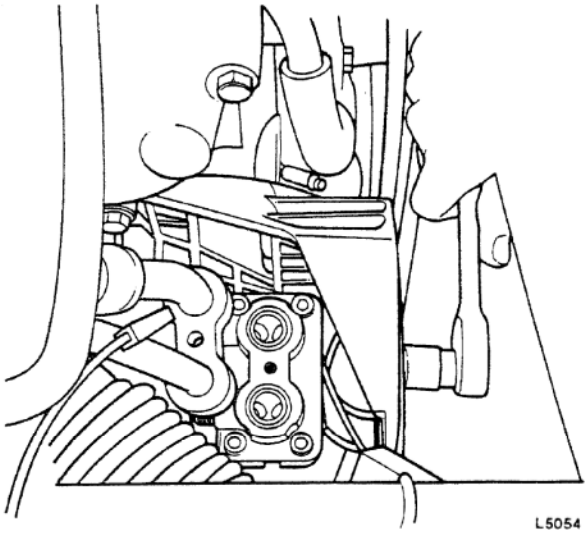
Compressor

Removal

1. Disconnect the negative battery cable.
2. Discharge the A/C refrigerant from the schraeder valve on the compressor. Follow all safety procedures.

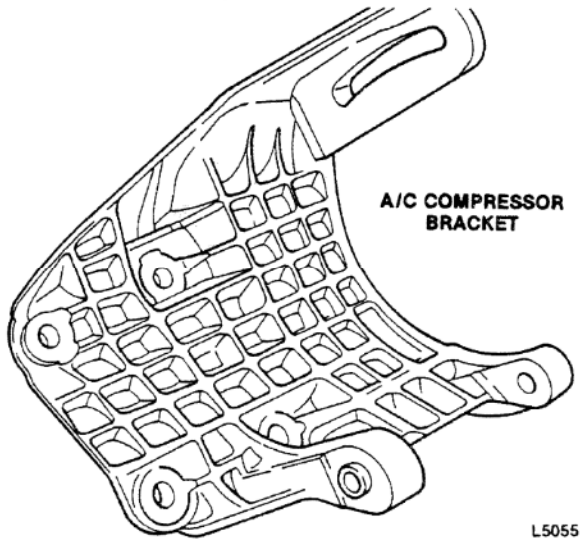


3. Detach the electrical connector from the electro-magnetic compressor clutch.
4. Loosen compressor bolts and remove the compressor drive belt.



REMOVAL AND INSTALLATION (Continued)

5. Detach compressor from bracket (three bolts).



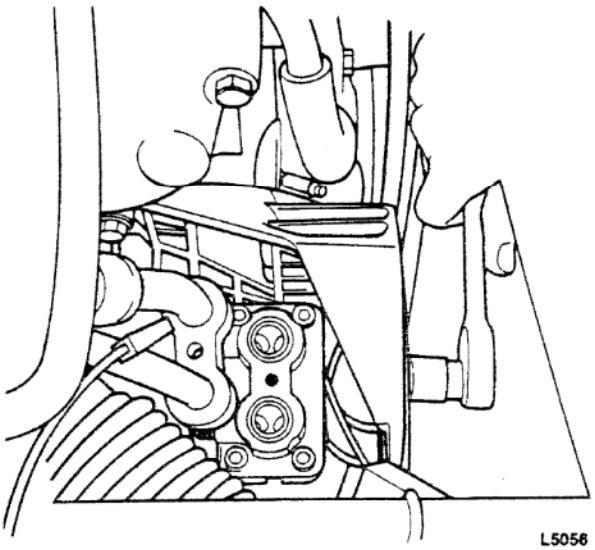
Installation

1. When installing a new compressor, 20 to 25 cc (.7 to .8 oz) of refrigerant oil must be drawn off the new compressor before it is installed. Do this by carefully opening the sealing plug on the low-pressure side so that pressure is released slowly. Then, turn the compressor over and let the oil run out.
2. Install the compressor on its bracket. Tighten bolts to 50 to 60 N·m (40 to 44 lb-ft).
3. Reconnect the electrical connector for the electromagnetic clutch and install pressure and suction hoses. Fit new O-rings if damaged. (New O-rings are always fitted to exchanged unit.) Lubricate O-rings with refrigerant oil before installing.
4. Recharge A/C system.
5. Reconnect battery.

Compressor Drive Belt

Removal

1. Loosen the three compressor support bolts and remove the drive belt.



Installation

1. Install the drive belt and tension it to 534 to 623 N·m (118 to 138 lb-ft). Tighten the three compressor support bolts.
2. Tighten the bolts to 70 to 75 N·m (52 to 56 lb-ft).

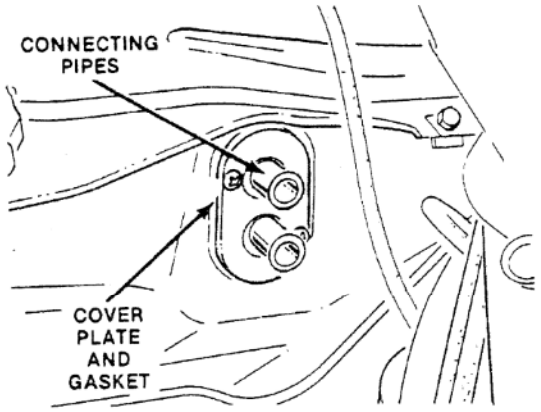
Heater Assembly

Removal and Installation

1. Disconnect the battery negative terminal.
2. Drain the engine coolant from the cooling system and remove the hoses from the heater core. Plug the hoses.
3. Carefully blow air into the upper of the two connecting pipes to remove residual coolant.

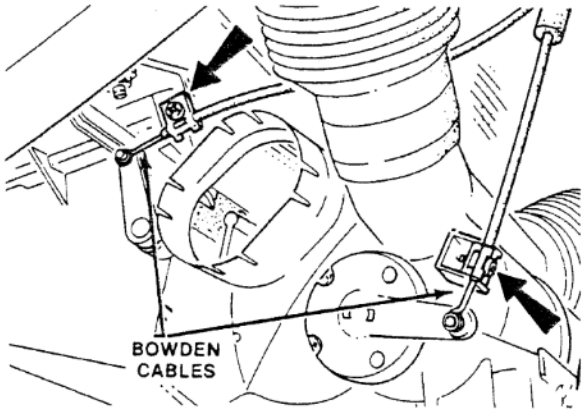
REMOVAL AND INSTALLATION (Continued)

4. Detach cover plate and gasket from the fire wall.



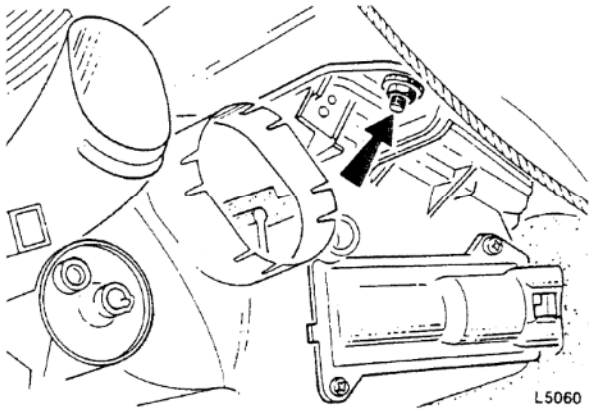
L5630

5. Remove the center console and draw it towards the rear.
6. Remove the side trim panel in the right-hand footwell.
7. Detach the heater control lever. Disconnect the leads from the glove compartment light, A/C blower switch and cigar lighter. Remove the lower right-hand dash panel.
8. Detach all duct hoses from the heater housing.
9. Detach both bowden cables from the heater housing.



L5631

10. Remove the heater from the dash panel (two screws) and draw it in until the water connectors of the heater core are clear of the fire wall. Then pull the heater assembly to the right.



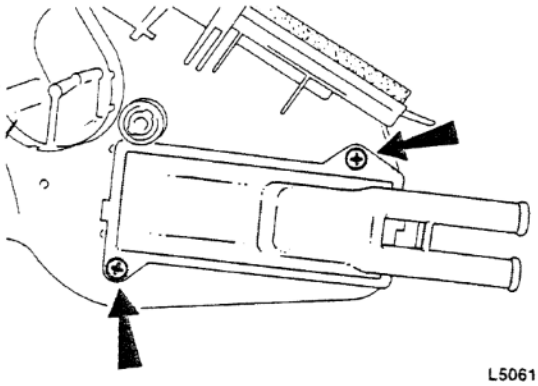
L5060

11. To install, reverse Steps 1 through 10.

Heater Core

Removal and Installation

1. Remove the heater core from the housing by removing the two screws and pulling the heater core out of the housing.
2. To install, reverse Step 1.



L5061

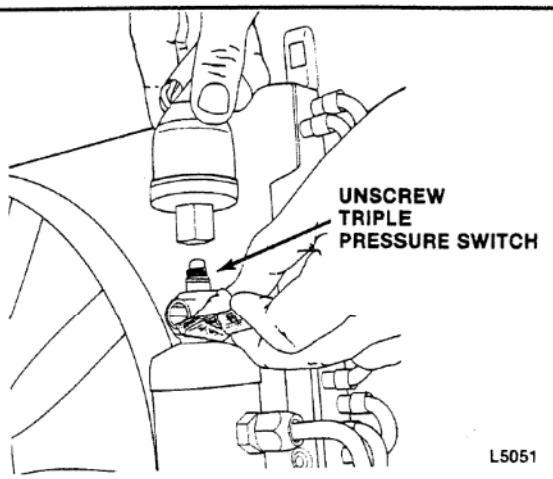
REMOVAL AND INSTALLATION

TRIPLE PRESSURE SWITCH

Removal and Installation

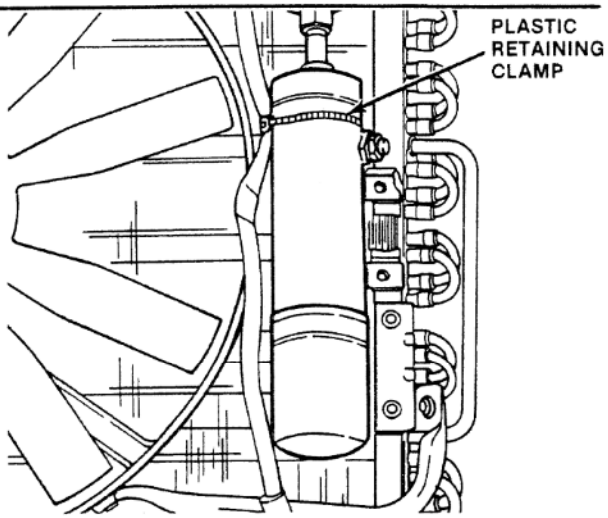
NOTE: This procedure can be done on-car or off-car.

1. Disconnect the negative battery cable.
2. Remove the triple pressure switch from the receiver/dryer.



NOTE: 1985 shown, 1986 similar

3. Cut the plastic retaining clamps holding the pressure switch line to the receiver/dryer and remove the triple pressure switch.
4. To install, thread the cycling pressure switch into the receiver/dryer finger tight and install a new plastic retaining clamp.

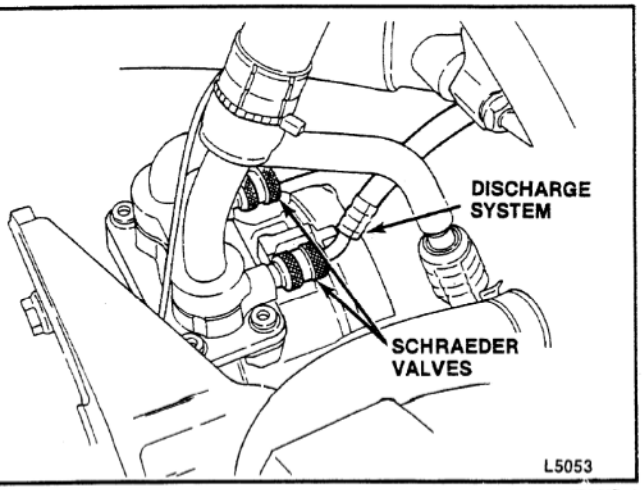


NOTE: 1985 shown, 1986 similar

COMPRESSOR

Removal

1. Disconnect the negative battery cable.
2. Discharge the A/C refrigerant from the schraeder valve on the compressor. Follow all safety procedures.

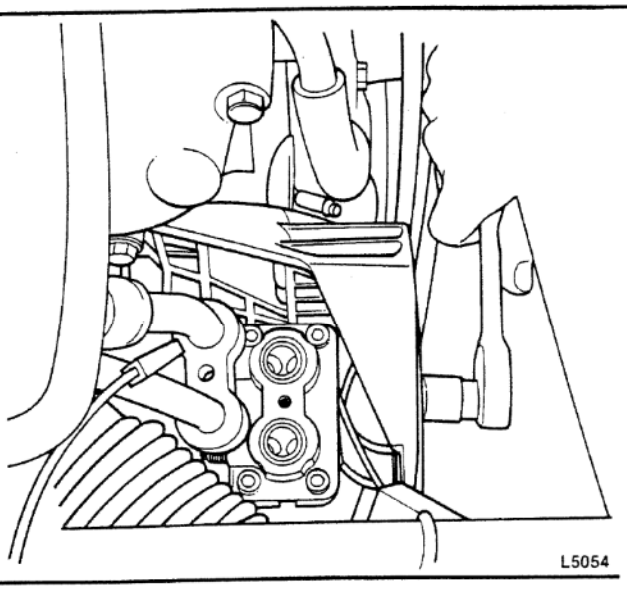


REMOVAL AND INSTALLATION

COMPRESSOR

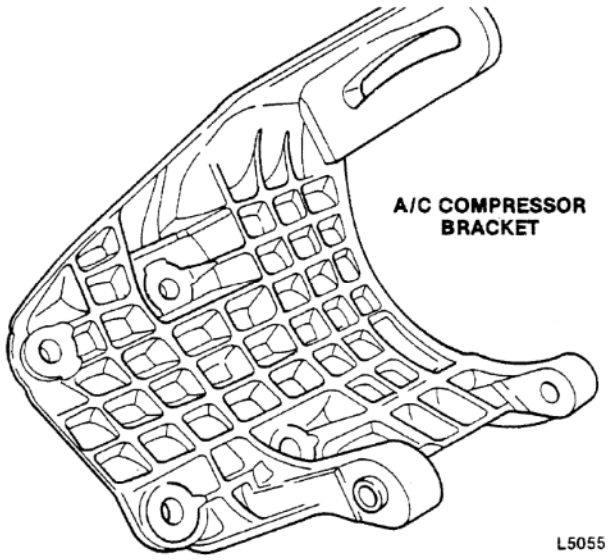
Removal (Continued)

3. Detach the electrical connector from the electro-magnetic compressor clutch.
4. Loosen compressor bolts and remove the compressor drive belt.



L5054

5. Detach compressor from bracket (three bolts).



L5055

Installation

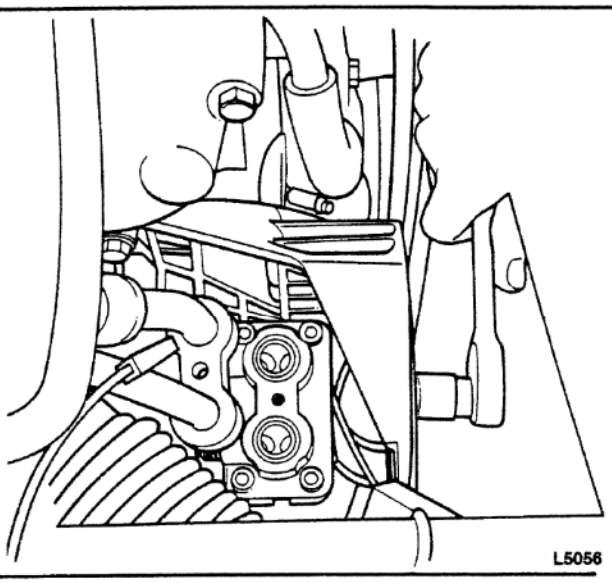
1. When installing a new compressor, 20 to 25 cc (.7 to .8 oz) of refrigerant oil must be drawn off the new compressor before it is installed. Do this by carefully opening the sealing plug on the low-pressure side so that pressure is released slowly. Then, turn the compressor over and let the oil run out.
2. Install the compressor on its bracket. Tighten bolts to 50 to 60 N·m (40 to 44 lb-ft).
3. Reconnect the electrical connector for the electromagnetic clutch and install pressure and suction hoses. Fit new O-rings if damaged. (New O-rings are always fitted to exchanged unit.) Lubricate O-rings with refrigerant oil before installing.
4. Recharge A/C system.
5. Reconnect battery.

REMOVAL AND INSTALLATION

COMPRESSOR DRIVE BELT

Removal

1. Loosen the three compressor support bolts and remove the drive belt.


L5056

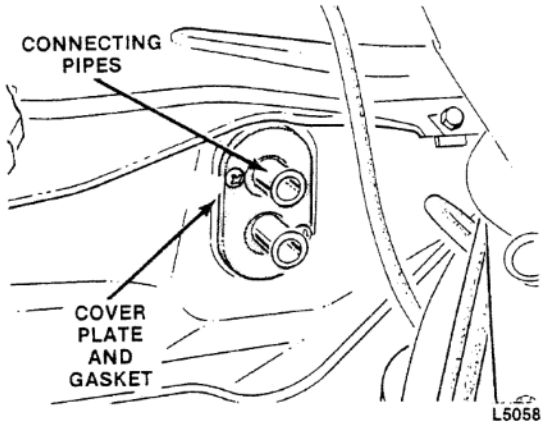
Installation

1. Install the drive belt and tension it to 534 to 623 N·m (118 to 138 lb-ft). Tighten the three compressor support bolts.
2. Tighten the bolts to 70 to 75 N·m (52 to 56 lb-ft).

HEATER ASSEMBLY

Removal and Installation

1. Disconnect the battery negative terminal.
2. Drain the engine coolant from the cooling system and remove the hoses from the heater core. Plug the hoses.
3. Carefully blow air into the upper of the two connecting pipes to remove residual coolant.
4. Detach cover plate and gasket from the fire wall.



L5058

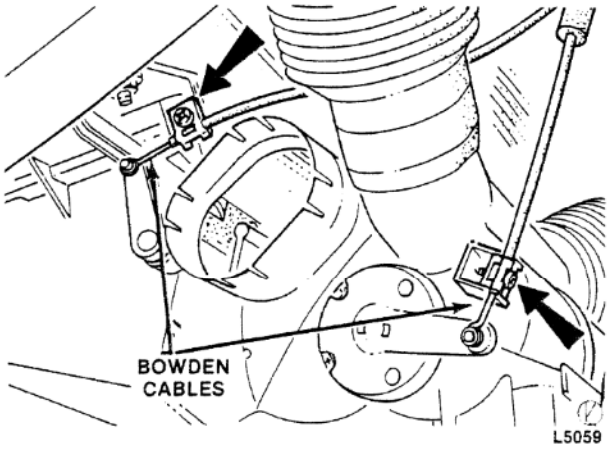
5. Remove the center console and draw it towards the rear.
6. Remove the side trim panel in the right-hand footwell.
7. Detach the heater control lever. Disconnect the leads from the glove compartment light, A/C blower switch and cigar lighter. Remove the lower right-hand dash panel.
8. Detach all duct hoses from the heater housing.

REMOVAL AND INSTALLATION

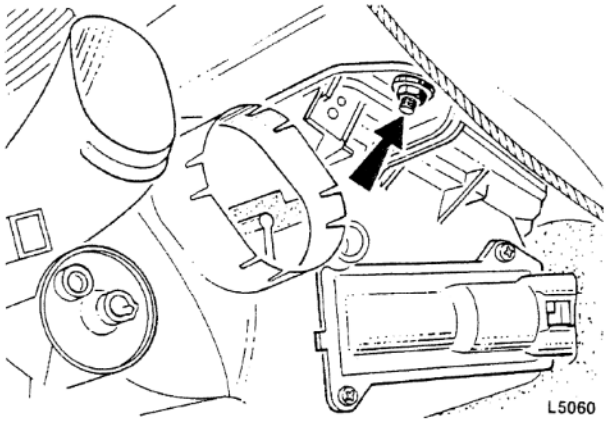
HEATER ASSEMBLY

Removal and Installation (Continued)

9. Detach both bowden cables from the heater housing.



10. Remove the heater from the dash panel (two screws) and draw it in until the water connectors of the heater core are clear of the fire wall. Then pull the heater assembly to the right.

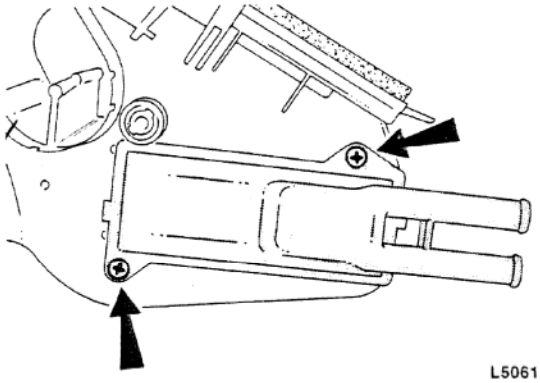


11. To install, reverse steps 1 through 10.

HEATER CORE

Removal and Installation

1. Remove the heater core from the housing by removing the two screws and pulling the heater core out of the housing.
2. To install, reverse step 1.



SECTION 36-32 A/C AND REFRIGERANT SYSTEMS SERVICE

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GENERAL INFORMATION

SAFETY PRECAUTIONS

The refrigerant used in the air conditioner system is Refrigerant-12. Refrigerant-12 is non-explosive, non-flammable, and non-corrosive; has practically no odor; and is heavier than air. Although it is classified as a safe refrigerant, certain precautions must be observed to protect the parts involved and the person who is working on the unit. Use only Refrigerant-12 such as Motorcraft YN-1A or YN-7 or equivalent. Do not use refrigerant that was canned for pressure-operated accessories (such as boat air horns). This type is not pure Refrigerant-12 and will cause a malfunction. Liquid Refrigerant-12, at normal atmospheric pressures and temperatures, evaporates so quickly that it has a tendency to freeze anything it contacts. **For this reason, extreme care must be taken to prevent any liquid refrigerant from coming in contact with the skin and especially the eyes.**

Refrigerant-12 is readily absorbed by most types of oil. For this reason, a bottle of sterile mineral oil and a quantity of weak boric acid solution must always be kept nearby when servicing the air conditioning system. Should any liquid refrigerant get into the eyes, immediately use a few drops of mineral oil to wash them out, then wash the eyes clean with weak boric acid solution. Seek a doctor's aid immediately even though irritation may have ceased. **Always wear safety goggles when servicing any part of the refrigerant system.** The Refrigerant-12 in the system is always under pressure. Because the system is tightly sealed, heat applied to any part could cause this pressure to build up excessively.

GENERAL INFORMATION (Continued)

SAFETY PRECAUTIONS (Continued)

WARNING: To avoid a dangerous explosion, never weld, use a blow torch, solder, steam clean, bake body finishes, or use any excessive amount of heat in the immediate area of any part of the air cooling system or refrigerant supply tank, while they are closed to the atmosphere, whether filled with refrigerant or not.

The liquid refrigerant evaporates so rapidly that the resulting refrigerant gas will displace the air surrounding the area where the refrigerant is released.

WARNING: To prevent possible suffocation in enclosed areas, always discharge the refrigerant from an air cooling system into the garage exhaust collector. Always maintain good ventilation surrounding the work area.

Although Refrigerant-12 gas, under normal conditions, is non-poisonous, the discharge of refrigerant gas near an open flame can produce a very poisonous gas. This gas is generated if the flame-type leak detector were to be used. **For this reason, do not utilize a flame-type leak detector. Only an electronic leak detector such as Rotunda Model 055-00015, or equivalent, can be used.** Make certain that Refrigerant-12 is both stored and installed in accordance with all state and local ordinances.

When admitting Refrigerant-12 gas into the A/C system, always keep the tank in an upright position if charging on the low side (gas) of the A/C system. If charging on the high side (liquid) of the A/C system, turn the can upside down to allow liquid Refrigerant R-12 to enter the system. If the tank is on its side or upside down, liquid Refrigerant-12 will enter the system and may damage the compressor.

NOTE: Never charge on the low side of the A/C system with the refrigerant in a liquid state.

SERVICE PRECAUTIONS

1. Never open or loosen a connection before discharging the system refrigerant.
2. When loosening a connection, if any residual pressure is evident, allow it to leak off before opening the fitting.
3. A system which has been opened to replace a component, or one which has discharged through leakage, must be evacuated before charging.
4. Immediately after disconnecting a component from the system, seal the open fitting with a cap or plug.
5. Before disconnecting a component from the system, clean the outside of the fittings thoroughly.
6. Do not remove the sealing caps from a replacement component until ready to install.
7. Refrigerant oil will absorb moisture from the atmosphere if left uncapped. Do not open any container until ready to use and install the cap immediately after using. Store the oil only in a clean moisture-free container.
8. Before connecting an open fitting, always install a new seal ring. Coat the fitting and seal with refrigerant oil before connecting.
9. When installing a refrigerant line, avoid sharp bends. Position the line away from the exhaust or any sharp edges which may chafe the line.
10. Tighten fittings only to the specified torque. The copper and aluminum fittings used in the refrigeration system will not tolerate over tightening.
11. When disconnecting a fitting, use a wrench on both halves of the fitting to prevent twisting of the refrigeration lines or tubes.
12. Do not open a refrigeration system or uncap a replacement component until the replacement component is ready to be installed. This will prevent condensation forming inside of the component.
13. Keep service tools and the work area clean. Contamination of a refrigeration system through careless work habits must be avoided.

GENERAL INFORMATION

REFRIGERANT CAN VALVE

All refrigerant cans are sealed and must be opened with a dispensing valve which, after it is installed, serves to puncture the can.

The can seals are of two types: flat-type seal and screw-type seal. The proper can valve must be used for each type of seal as described below.

Flat-Type Seal Can Valve

This valve is either a one-piece (cam-lock) type, or a two-piece type.

NOTE: Be sure that the sealing gasket on the dispensing valve is in good condition.

To install a one-piece valve, turn the valve handle to the open position, and secure the locking lugs over the can flange. Then, lock the valve to the can by turning the cam-lock or the locking nut. After the valve is installed, turn the handle completely in. This will close the valve and, at the same time, pierce the can.

To install a two-piece valve, close the valve by turning the handle all the way in. Turn the locking base to its outer limit, and secure the locking lugs over the can flange. Then, making sure the valve handle is kept closed, turn the entire valve assembly down to pierce the can.

NOTE: A safety-type can valve can be used to prevent a backflow of refrigerant from the system and, thus, prevent excessive can pressure.

Screw-Type Seal Can Valve

To install this kind of valve, first be sure that the valve is completely closed. Then, install the valve by screwing the refrigerant can into the valve until it is tight. This will pierce the can.

REPLACEMENT GUIDELINES

RECEIVER-DRYER

Replace the receiver-dryer when:

- The receiver-dryer is restricted, plugged or perforated.
- The system has been left open for more than 24 hours.
- There is evidence of moisture in the system (i.e., internal corrosion of metal lines or dark, thick refrigerant oil).
- The system is contaminated (such as if the compressor has seized).

Do not replace the receiver-dryer every time:

- There is a loss of refrigerant.
- A component such as a condenser, evaporator, or compressor (except as described above) is changed.

DIAGNOSIS AND TESTING

VISUAL INSPECTION

Obstructed air passages, broken belts, disconnected or broken wires, loose clutch, loose or broken mounting brackets.

A refrigerant leak will usually appear as an oily residue at the leakage point in the system. The oily residue soon picks up dust or dirt particles from the surrounding air and appears to be heavy dirt-impregnated grease.

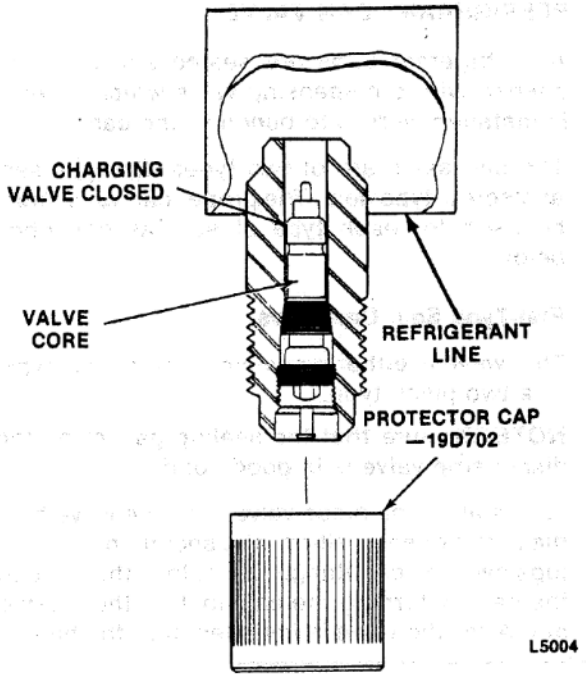
Most common leaks are caused by damaged or missing O-ring seals at the various hose and component connections. When new O-rings are replaced, lubricate with refrigerant oil and care should be taken to keep lint from shop towels or rags from contaminating the internal surfaces of the connection.

DIAGNOSIS AND TESTING

VISUAL INSPECTION (Continued)

Missing service gauge port valve caps can also cause a refrigerant leak. If this important primary seal is missing, dirt will enter the area of the A/C charging valve core. When the service hose is attached, the valve depressor in the end of the service hose forces the dirt into the valve seat area and the dirt will destroy the sealing surface of the A/C charging valve core. When a service gauge valve port cap is missing the protected area of the A/C charging valve core should be cleaned and a new service gauge valve core cap should be installed.

CAUTION: Service gauge port valve caps must be installed finger-tight. If tightened with pliers, the sealing surface of the service gauge port valve may be damaged.

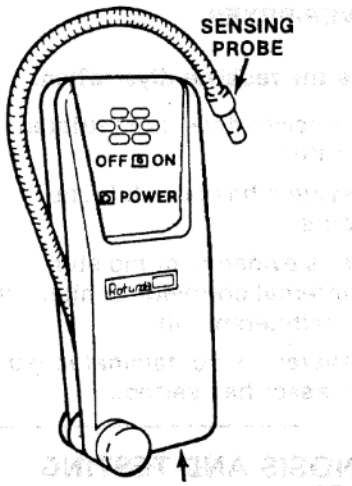


CHECKING FOR LEAKS

A testing device can be used to detect leaking refrigerant gas. This device is called the Electronic Leak Detector Rotunda Model 055-00015 or equivalent.

The electronic leak detector is operated by switching the control to the ON position, in which all calibrations are done automatically.

Attach the manifold gauge set. Leave both manifold gauge valves at the maximum clockwise (closed) position. Both gauges should show approximately 60 to 80 pounds pressure at 75°F (24°C) with the engine not running. If very little or no pressure is indicated, leave the vacuum pump valve closed, open the Refrigerant-12 tank valve, and set the low pressure (suction) manifold gauge valve to the counterclockwise position. This opens the system top tank pressure. Check all connections, the compressor head gasket, oil filler plug, and shaft seal for leaks, using a good refrigerant leak detector.



Move the probe at about 25.4 mm (1 in.) per second in the suspected area. When escaping refrigerant gas is located, the beeping signal will increase in beeps per second. If the gas is relatively concentrated, the signal will be increasingly shrill. Follow the instructions included with the detector to improve handling and operating techniques.

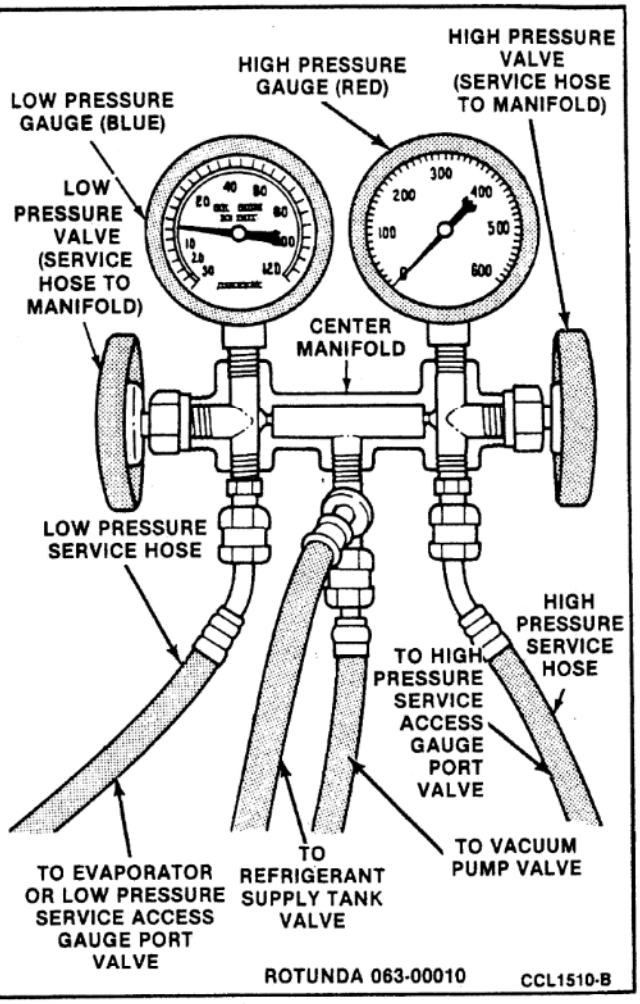
REFRIGERANT SYSTEM SERVICE

MANIFOLD GAUGE SET ATTACHMENT

When performing any of the various tests, the low-side and high-side service hoses must be connected to the vehicle's air conditioning system. If charging station equipment is being used, refer to the manufacturer's instructions for correct installation.

To attach a manifold gauge set to the service gauge port valves, proceed as follows:

1. Turn both the low and high pressure gauges clockwise to close.
2. Remove the cap from the high and low pressure service (Schraeder) gauge port valves.
3. If the manifold gauge set or charging station refrigerant hoses do not have the valve depressing pins in them, install fitting adapters T71P-19703-S and R or equivalent (containing valve depressing pins) on the manifold gauge set low and high pressure hoses.
4. Connect the high and low pressure refrigerant hoses with depressing pins or adapters to the respective high and low pressure service gauge port valves at the compressor manifold. The special adapter must be used on the high pressure service gauge port valve.



SYSTEM DISCHARGING

Discharge the refrigerant from the system before replacing any part of the refrigerant system.

1. Remove the protective caps from the high and low pressure service gauge port valves.
2. Turn both manifold gauge valves fully clockwise to close the high and low pressure hoses to the center manifold and hose.
3. Connect the manifold gauge set high and low pressure hoses, with adapters, to the respective high and low pressure service gauge port valves.
4. Place the open end of the center hose in a garage exhaust outlet.
5. Slowly depressurize the refrigeration system by opening the low pressure valve of the manifold gauge set a slight amount and allow the refrigerant to discharge slowly from the system. Ensure no oil escapes during discharging.
6. After the system is nearly discharged, open the high pressure gauge valve slowly to avoid losing any refrigerant oil and allow any refrigerant remaining in the compressor and high pressure line to discharge.

REFRIGERANT SYSTEM SERVICE

SYSTEM EVACUATING

1. Discharge the refrigerant system as outlined.
2. Be certain the manifold gauge set is connected as follows:
   a. Low pressure hose connected to the low pressure service gauge port on the top compressor service gauge port on the suction side identified with "S."
   b. High pressure hose connected to the high pressure service gauge port on the compressor discharge line at the condenser connection. An adapter is necessary at this service gauge port identified with a "D."
   c. Manifold gauge set center hose connected to a vacuum pump.
   d. Manifold gauge set to refrigeration supply connector.
3. Open the manifold gauge set valves and start the vacuum pump.
4. Evacuate the system with the vacuum pump until the low pressure gauge reads at least 25 inches of mercury (vacuum) and as close to 30 inches as possible. Continue the vacuum pump operations for 15 minutes. If a part of the system has been replaced, continue the vacuum pump operation for an additional 20 to 30 minutes. The refrigerant supply cylinder should be evacuated if no refrigerant was left in the cylinder (if there is refrigerant in the cylinder, evacuation is not required). After a vacuum of 25 mm (min) has been reached, the cylinder should be charged (close valve behind cylinder prior to charging) to the specified amount of refrigerant.
5. When evacuation of system is complete, close manifold gauge set valves and turn off vacuum pump. Close valve on pump.
6. Observe the low side gauge to be sure the system holds vacuum for five minutes. If vacuum is held for five minutes, proceed to charging the system. If vacuum is not held for five minutes, leak test the system, service leak(s) and again evacuate the system.

SYSTEM CHARGING

Pressurized Charging (If service equipment is applied with heat element)

1. Open **high pressure** valve on manifold open valve on charging cylinder.
2. Switch on heating element.
3. When all the refrigerant has been extracted from the cylinder, close all valves and disconnect the hoses from the service valve A/C system.

NOTE: While disconnecting the charging hoses (loosening of swivel nuts), press on the hose connector to valve in order to minimize refrigerant escaping.

4. Install protective caps.

Charging on Suction Side (without heat element)

1. Open low pressure valve.
2. Open the valve on the charging cylinder.
3. Allow freon to flow into the A/C system.
4. When it can be seen that the refrigerant flow has stopped, start the motor and run the engine at 1500 rpm max.
5. Switch the air conditioning on, to position 3 (outside air).
6. When the charging cylinder is empty, close the valves on the charging cylinder and manifold.
7. Disconnect the charging hoses.
8. Install protective caps.

Charging from a Small Container

1. If a charging cylinder is available, charge the cylinder with the specified amount of R12 and proceed as shown above.
2. If no charging cylinder is available, proceed utilizing the "Charging from a Small Container" shown below.

REFRIGERANT SYSTEM SERVICE

CHARGING OF CHARGING CYLINDER

After the cylinder has been evacuated, charge the cylinder with the specified amount of R12 as follows:

1. Turn the container upside down (charging valve on bottom).
2. Open valves on container and cylinder and allow the refrigerant to pass into the cylinder.
3. To support the process, open the valve on top of the cylinder slightly to allow a better flow condition.

CHARGING FROM SMALL CONTAINER

Refrigerant-12 is available in cans as small as 15 ounces.

WARNING: Do not open the manifold gauge set high pressure (discharge) gauge valve when charging with small container. To do so can cause the small refrigerant container to explode.

1. A special refrigerant dispensing valve and valve retainer such as Motorcraft VYT-280, Rotunda 023-00009, or equivalent, is required for connecting the small can to the A/C system. Use only a safety type refrigerant dispensing valve and follow the manufacturer's instructions when attaching the valve to the refrigerant container.
2. Connect the manifold gauge set to the system. Connect the hose (normally connected to the R-12 tank) to the special valve on the small can adapter. Make sure that the valve is closed fully in the clockwise position.
3. Once the can is connected, charge the system as outlined. When the can is empty, close the valve and remove the empty can. Connect a new can, open the valve again and continue charging until the specified weight of R-12 has entered the system.

Note the capacity of the refrigerant cans. If they contain less than 16 ounces of refrigerant, compensation for weight less than 16 ounces must be made for each can of refrigerant used. For example, when a half pound of refrigerant is needed (such as with a 2-1/2 pound charge capacity), and 14 ounce cans of refrigerant are used, all but two ounces of the third can of refrigerant should be installed in the system. Weigh the can to make sure the correct amount of refrigerant is installed.

REFRIGERANT SYSTEM SERVICE

PURGING REFRIGERANT SYSTEM TO REMOVE AIR AND MOISTURE VAPOR

The triple evacuation procedure should be used when there are definite indications of moisture in the system. The procedure is effective in removing small amounts of moisture from the refrigeration system. However, if the system is contaminated with a large quantity of water, complete system flushing will be required.

The principle of the three evacuations is simple. The first pull-down removes about 90 percent of the air and moisture content.

With the next evacuation, the mixture will be drawn out so that only about 10 percent of the remaining air and moisture content remains.

The second purge with new, dry R-12 will mix with this 10 percent, and the third evacuation will finish the job by drawing out practically all the remaining vapors.

If any water was present in the system at the start of the procedure, most of it will still be there. This is because a short amount of vacuum is not enough to boil and vaporize the water. The R-12 purges, in passing over the liquid, will absorb only a relatively small amount of water.

This procedure is effective only when no water is in the system and should not be used when there is an indication of water in the system.

CLEANING A BADLY CONTAMINATED REFRIGERANT SYSTEM

A badly contaminated system presents a special problem and is the result of using the wrong refrigerant oil, or the compressor continuing to run during a refrigerant system failure, or improper cleaning following a previous failure. It may also be the result of prolonged operation with excessive moisture or water in the system.

If preliminary inspection shows that the system is badly contaminated with water, carbon, and other decomposition products from the failure, it will be necessary to remove all these contaminants as well as clean and service or replace the compressor, replace the expansion valve and the receiver-dryer.

FLUSHING AGENTS

Remember, however, that as the ambient temperature increases, the refrigerant becomes more difficult to use as a flushing agent because of its increased tendency to vaporize rather than remain a liquid.

WARNING: Extreme caution and adherence to all safety precautions governing the use of refrigerant are necessary when flushing a system.

After the system or individual components have been cleaned, the excess flushing refrigerant should be removed. This is done by blowing out Refrigerant R-12 or nitrogen.

CAUTION: Be sure to use a pressure regulator on the nitrogen supply tank if nitrogen is used. The nitrogen supply tank pressure is extremely high and serious damage can result if the supply tank is not regulated.

REFRIGERANT FLUSHING INFORMATION CHART

Refrigerant	Vaporizes °C(°F)①	Approximate Closed Container Pressure① kPa (psi)②					
		15.57°C (60°F)	21.13°C (70°F)	26.69°C (80°F)	32.25°C (90°F)	37.81°C (100°F)	Adaptability
R-12	– 29.80 (– 21.6)	393 (57)	483 (70)	579 (84)	689 (100)	807 (117)	Self Propelling

①At sea level atmospheric pressure.
②kPa (psi) unless otherwise noted.
③F-11 is also available in pressurized containers. This makes it suitable for usage when special flushing equipment is not available. However, it is more toxic than R-12 and F-114.

CL3952-A

REFRIGERANT SYSTEM SERVICE (Continued)

CLEANING SYSTEM COMPONENTS

Cleaning the refrigerant system components requires removal and replacement of some of the components and back flushing the condenser assembly. Periodic cleaning of the exterior surface of the condenser is helpful to permit good air circulation through the condenser fins.

The Safety Precautions should be observed at all times. If the components in the following procedure are flushed with a refrigerant other than R-12, it is necessary to remove the excess flushing refrigerant by blowing out with Refrigerant R-12 or with nitrogen. If nitrogen is used, a pressure regulator should be installed on the nitrogen supply tank to reduce the extremely high nitrogen supply pressure.

When cleaning a contaminated refrigerant system using the continuous circulation method, follow the method as recommended by the manufacture of the special flushing equipment.

ADDING REFRIGERANT OIL

It is imperative that the specified type and quantity of refrigerant oil be maintained in a refrigerant system for proper operation. A surplus of oil, the wrong oil viscosity or insufficient oil will all cause refrigerant system problems. Insufficient oil or the wrong oil results in poor lubrication and possible compressor damage. A surplus of oil allows too much oil to circulate with the refrigerant, causing the cooling capacity of the system to be reduced.

When it is necessary to replace a component of the refrigeration system, certain procedures must be followed to ensure that the total oil charge on the system is correct after the new part is installed. During normal A/C operation, some refrigeration oil is circulated through the system with the refrigerant and some is retained with the compressor. If certain components of the refrigerant system are removed for replacement, some of the refrigerant oil will go with the component. To maintain the original oil charge, it is necessary to compensate for the oil loss by adding oil to the system with the replacement part. The procedures for replacing lost oil are as follows:

Compressor

Refer to the compressor service section of this manual for compressor refrigerant oil information and replacement. Drain 20 cc of refrigerant oil out of the compressor if the compressor is being replaced.

Receiver-Dryer

Add 5 cc (0.1 oz) of refrigerant oil to the receiver-dryer if it is replaced.

NOTE: If a new unit is being fitted, it is necessary to add a further 5 cc (0.5 oz) of refrigerant oil. If the original unit is being reinstalled, it is not necessary to add an additional 5 cc.

Evaporator Core

Add 15cc (0.5 oz) ounces of clean refrigerant oil to the receiver-dryer inlet tube whenever the evaporator core is replaced. This will compensate for the refrigerant oil lost in the replaced evaporator core.

Condenser

Add 15cc (0.5 oz) ounces of clean refrigerant oil to the condenser or the receiver-dryer if the condenser is replaced.

Other Refrigerant System Components

Replacement of hoses requires the addition of 5cc (max.) (0.1 oz) of refrigerant oil. Replacement of other refrigerant system components such as compressor valves, pressure switch, etc. does not require the addition of refrigerant oil.

SECTION 36-38 COMPRESSOR AND CLUTCH

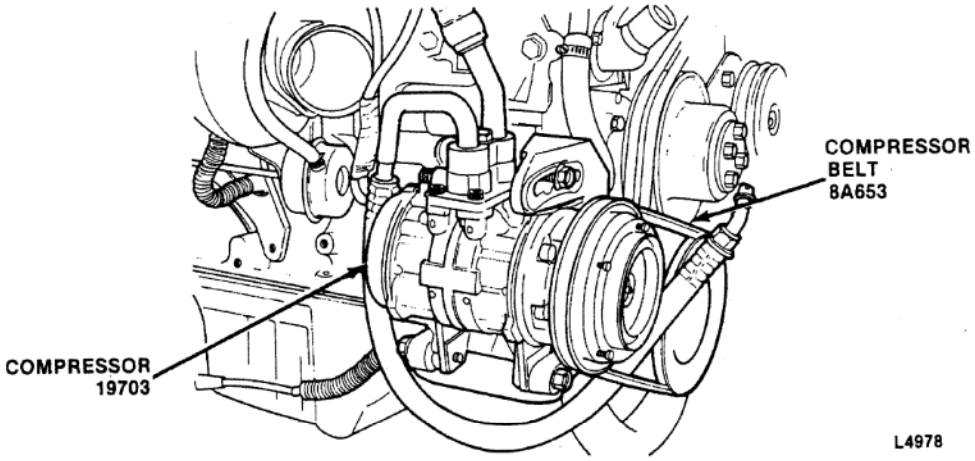
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DESCRIPTION 1

TESTING 2
Compressor External Leak Test 2

REMOVAL AND INSTALLATION
Compressor Clutch 2
Service Valve O-Rings 5



DESCRIPTION

The Nippondenso 10P15 compressor, used on the XR4Ti, is a swash-plate design, ten piston, five-cylinder compressor driven by a belt from the engine crankshaft pulley. Refrigerant lines are connected to the manifold which is connected to the compressor. Service of the compressor is limited to the replacement of the clutch and service valve O-rings between the manifold and refrigerant lines.

A magnetic clutch is used to drive the compressor clutch. When voltage is applied to the clutch field coil, the clutch plate and hub assembly (which is attached to the compressor shaft) is drawn by magnetic force toward the pulley which rotates freely on the compressor shaft. The magnetic force of the field coil locks the clutch plate and hub assembly and the pulley assembly together as one unit. The compressor shaft then turns with the pulley for compressor operation. When voltage is removed from the clutch field coil, springs in the clutch plate and hub assembly pull the plate away from the pulley and the compressor shaft ceases to rotate.

TESTING

COMPRESSOR EXTERNAL LEAK TEST

NOTE: This procedure can be performed either on-car or off-car.

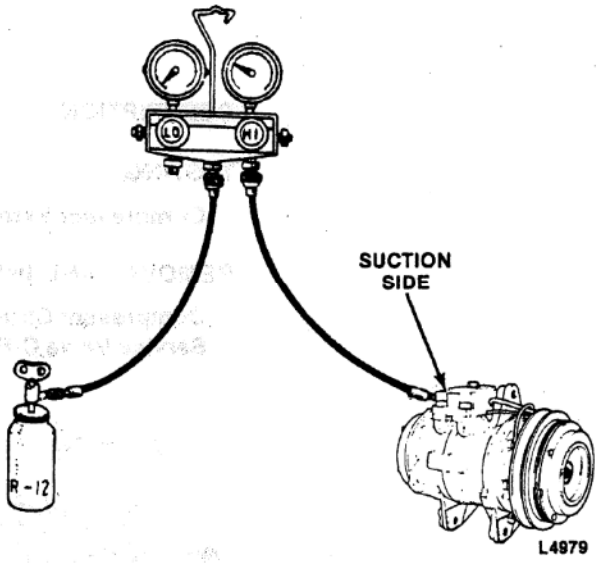
WARNING: Be sure the refrigerant system is discharged before performing the external leak test.

1. Charge the compressor with refrigerant through charging valve on the suction side until the correct pressure is reached.

Ambient Temperature	Pressure
9°C (49°F)	310 kPa (50 psi)
15°C (59°F)	391 kPa (57 psi)
20°C (70°F)	467 kPa (68 psi)
25°C (77°F)	552 kPa (81 psi)
30°C (86°F)	645 kPa (94 psi)

2. Using a leak detector, Rotunda Model 055-00015, or equivalent, check the compressor for leaks.

   If leaks are found at the manifold, replace the manifold O-rings. If external leaks are found elsewhere on the compressor, replace the compressor.



REMOVAL AND INSTALLATION

COMPRESSOR CLUTCH

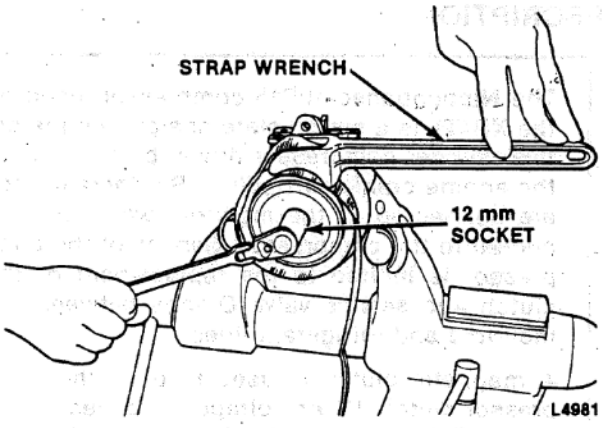
NOTE: This procedure includes removal and installation of the clutch hub, pulley, and field coil. The compressor should be replaced and not disassembled beyond this point.

Removal

1. Mount compressor in a vise.

CAUTION: Be careful not to clamp the compressor too tightly in the vise.

2. Using a 12 mm socket and strap wrench, remove the clutch hub retaining nut.

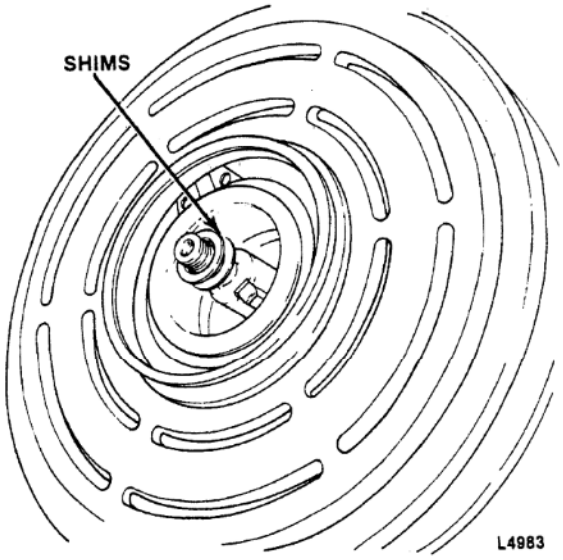


REMOVAL AND INSTALLATION

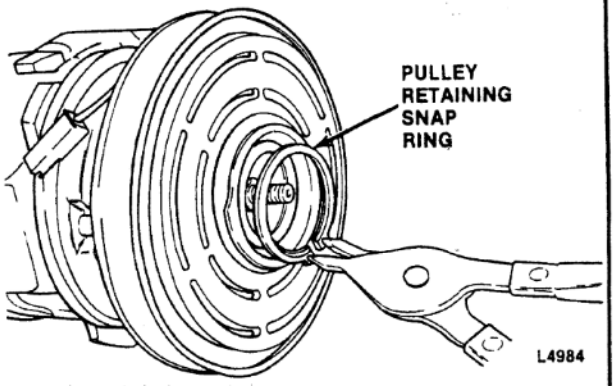
COMPRESSOR CLUTCH

Removal (Continued)

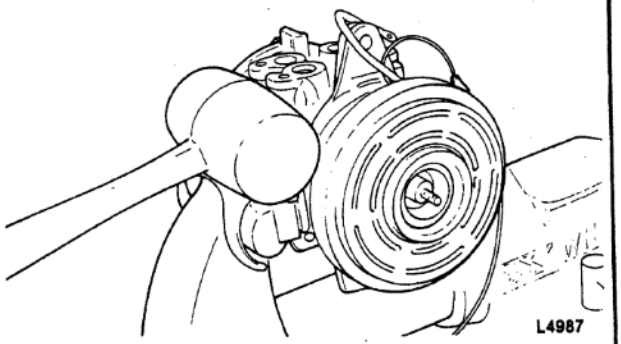
3. Remove the clutch hub.
4. Remove the shims from the compressor shaft.



5. Using snap ring pliers, remove the pulley retaining snap ring.



6. Using a plastic hammer, tap the pulley off the shaft.



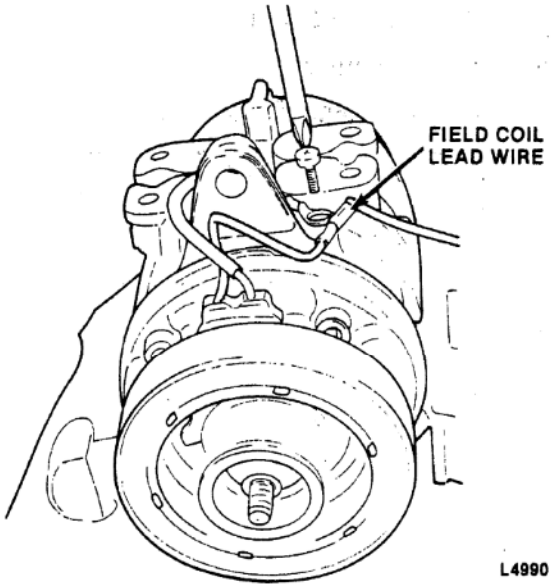
CAUTION: Be careful not to damage the pulley when tapping the pulley with a hammer.

REMOVAL AND INSTALLATION

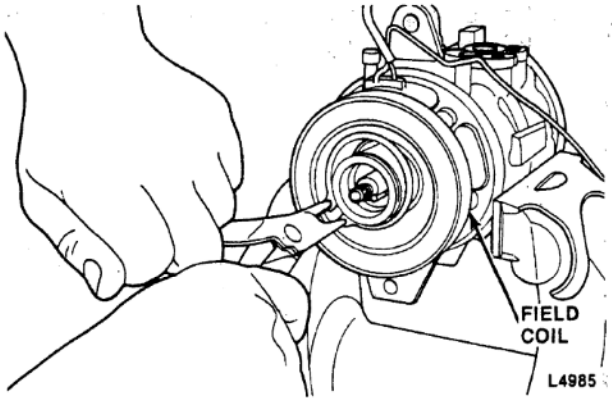
COMPRESSOR CLUTCH

Removal (Continued)

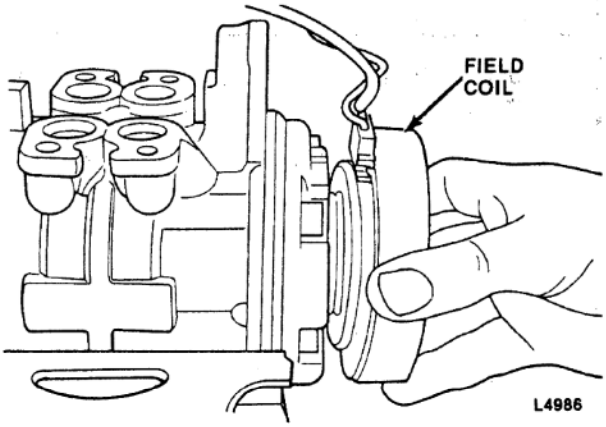
7. Disconnect the field coil lead wires from the compressor housing.



8. Using snap ring pliers, remove the snap ring retaining the field coil.

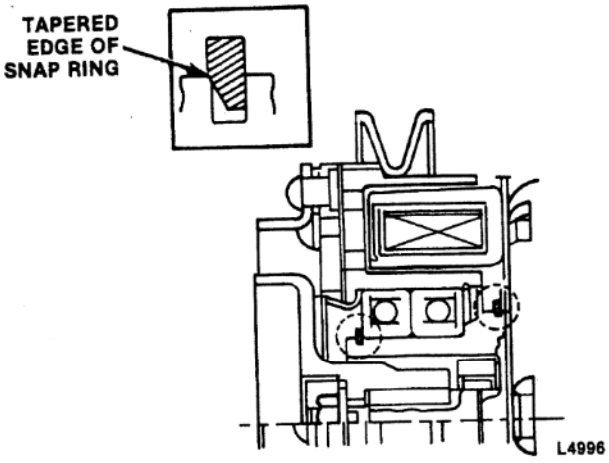


9. Remove the field coil from the compressor.



REMOVAL AND INSTALLATION

COMPRESSOR CLUTCH



Installation

1. Install the field coil on the compressor. Using snap ring pliers, install the snap ring retaining the field coil.

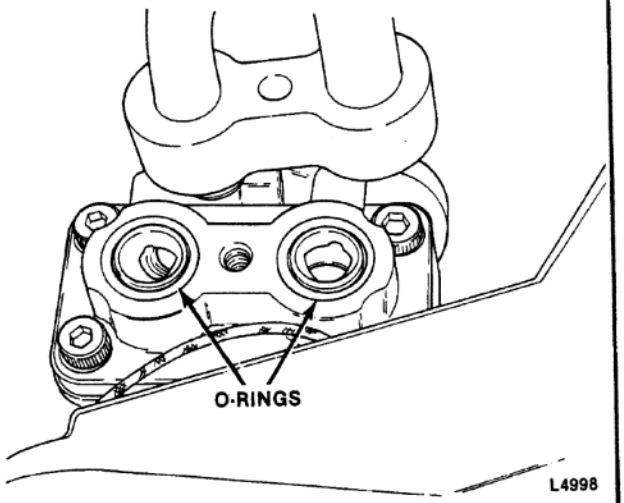
NOTE: Tapered edges of snap ring must be set on the upper side.

2. Connect the field coil lead wires to the compressor housing.
3. Install the pulley on the compressor shaft. Install pulley retaining snap ring using snap ring pliers.
4. Adjust the clearance between the hub and pulley by inserting the shims on the compressor shaft. Standard clearance is 0.4 to 0.7 mm (0.116 to 0.028 in.). Check clearance with a feeler gauge. If the clearance is not within tolerance, add or reduce the number of shims to obtain the standard clearance.
5. Using a torque wrench and strap wrench, install the clutch hub retaining nut. Tighten to 15 to 17 N·m (11 to 12.7 lb-ft).

SERVICE VALVE O-RINGS

Removal

1. Remove the refrigerant lines from the manifold by removing the No. 40 torx bit screw.
2. Remove the O-rings from the service valves and discard them.



Installation

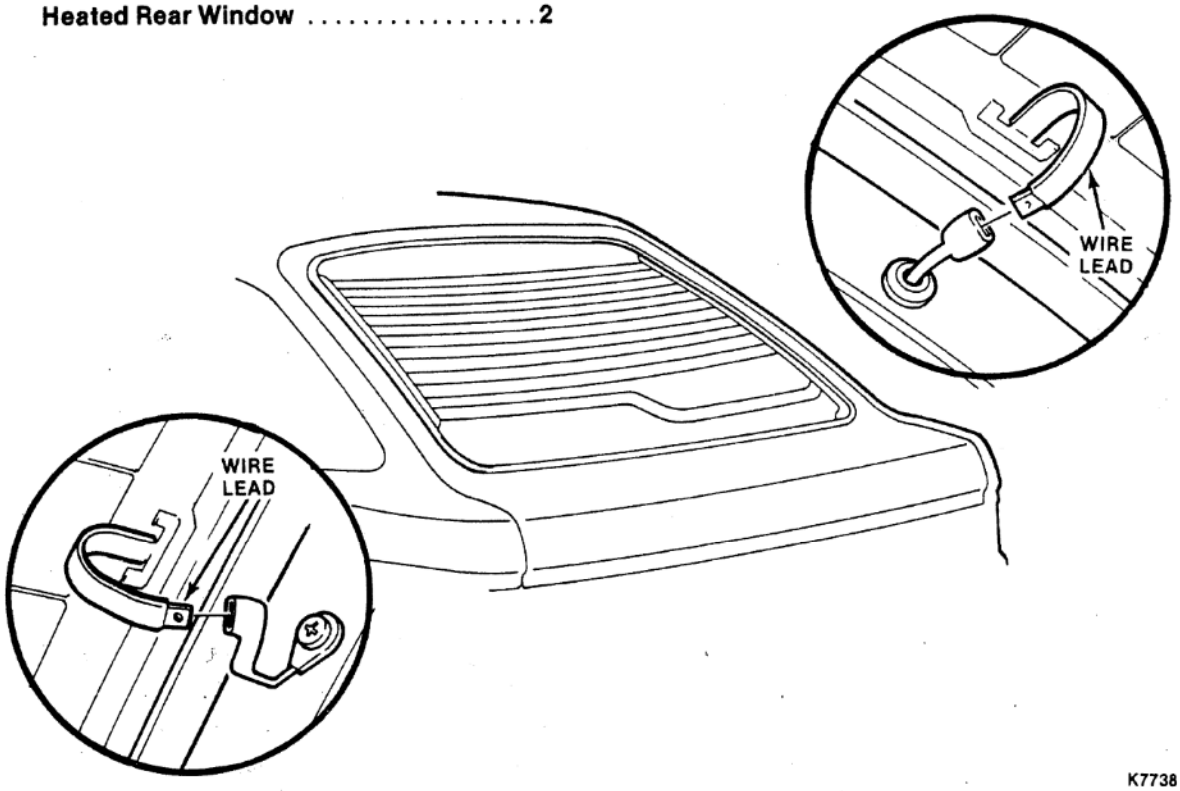
1. Coat the new O-rings with refrigerant oil. Install the O-rings in the service valves. Install No. 40 torx bit screw.



SECTION 36-86 HEATED REAR WINDOW SYSTEM

CONTENTS

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DESCRIPTION	1
TESTING	
Rear Window Grid Wire Test	2
REMOVAL AND INSTALLATION	
Heated Rear Window	2
MAJOR SERVICE OPERATIONS	
Rear Window Grid Wire Service	3
Lead Wire Terminal Service	4



DESCRIPTION

The heated rear window system consists of a series of grid lines baked on the inside surface of the rear window and system wiring. Power for the rear window grids is supplied directly from the battery side of the starter motor relay through a fuse link which protects the circuit.

NOTE: On vehicles equipped with a rear screen antenna, a control assembly is required.

TESTING

REAR WINDOW GRID WIRE TEST

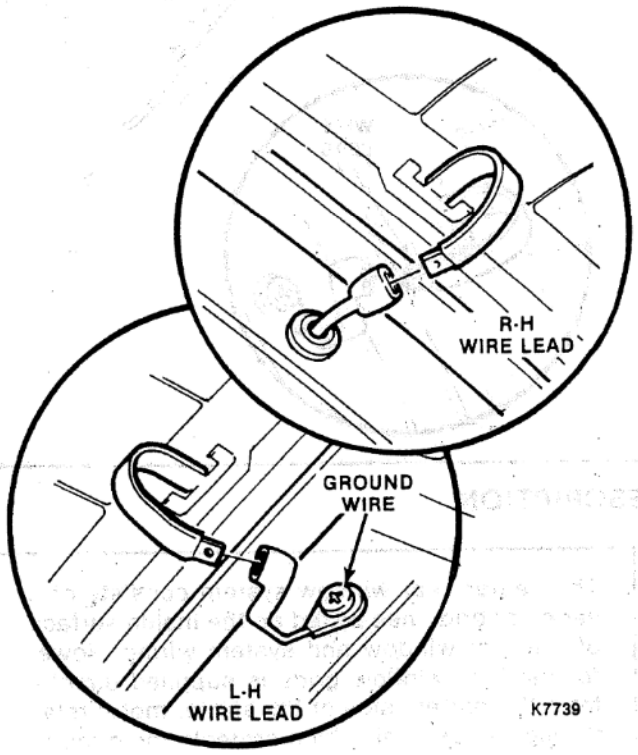
1. Using a strong lamp inside the vehicle, visually inspect the wire grid from the outside. A broken grid line will appear as a brown spot.
2. Run the engine at idle. Set the control switch to ON. The indicator light should come on.
3. Working inside the vehicle with a 12-volt DC voltmeter, contact the grid lines on the rear window. Contact positive lead to battery side and negative lead to ground side. The meter should read 10 to 13 volts. A lower voltage reading indicates a loose ground wire (pigtail) connection at the ground attaching screw.
4. Contact a good ground point with the negative lead of the meter. The voltage reading should not change.
5. With the negative lead of the voltmeter grounded, touch each grid line of the heated rear window at its midpoint with the positive lead. A reading of approximately 6 volts indicates that the line is good. A reading of 0 volts indicates that the line is broken between the midpoint and the end of the grid line. A reading of 12 volts indicates that the circuit is broken between the midpoint of the grid line and ground.

REMOVAL AND INSTALLATION

HEATED REAR WINDOW

Removal

Disconnect wire leads at each end of the glass. Remove window. Refer to Section 43-11 for removal procedures.



Installation

Install window in accordance with Section 43-11. Connect wire leads at each end of the glass.

MAJOR SERVICE OPERATIONS

REAR WINDOW GRID WIRE SERVICE

Any break in the grid longer than 25 mm (1 in.) cannot be serviced. The rear window must be replaced. For breaks less than 25 mm (1 in.), use the following procedure:

NOTE: If the first layer of the heated rear window grid is damaged or missing, it will be necessary to apply brown acrylic touch-up paint, Part No. AL81-5477-B or equivalent, on the glass prior to applying the heated backlight grid compound, Part No. D8AZ-19562-A, or equivalent.

Inoperative grid wires on heated rear windows should be serviced by using Heated Backlight Grid Component, Part No. D8AZ-19562-A, or equivalent.

Surface Preparation

1. The vehicle should be brought inside and permitted to come to room temperature.
2. Clean the entire grid line repair area with Ford Glass Cleaner, D8AZ-19C507-A, or equivalent, or other suitable cleaning solvent to remove all dirt, wax, grease, oil or other foreign matter. It is important that the repair area be clean and dry.

CAUTION: Do not use scrapers, sharp instruments, or abrasive cleaners on the interior surface of the rear window, as this may cause damage to the grid lines.

Mixing

The bottle of Grid Repair Compound and touch-up paint (if needed) must be at room temperature. Shake bottle for at least one minute for thorough mixing. Shake frequently during use.

Application

1. Mark the location of the break on the outside of the window.
2. Using cellulose tape, mask off the area directly above and below the grid break. The break area should be at the center of the mask and the tape gap must be no wider than the existing grid line.
3. If both brown and silver layers of the grid are broken or missing, apply a coating of the brown touch-up paint across the break area first. Two coats may be necessary to obtain the proper color. Allow the touch-up paint to dry.
4. Apply the grid repair compound in several smooth continuous strokes (allowing three to five minutes drying time between coats) across the break area using the brush applicator in the cap. Extend the service coating at least 6 mm (1/4 in.) on both sides of the break area.
5. Allow to dry for five minutes, then remove the mask.
6. Check the outside appearance of the grid repair. If the silver grid repair compound is visible above or below the grid, remove the excess.

This can be done by placing a single-edge razor blade on the glass parallel to the grid and scraping gently toward the grid.

CAUTION: Be careful not to damage the grid line with the razor blade.

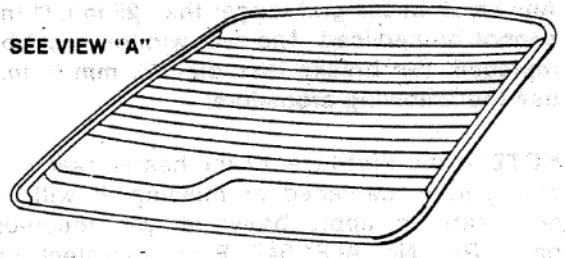
Curing

The grid repair compound will air dry in about one minute and can be energized within three minutes. Optimum hardness and adhesion occurs after approximately 24 hours. At that time, the serviced area may be cleaned with a mild window cleaner.

MAJOR SERVICE OPERATIONS (Continued)

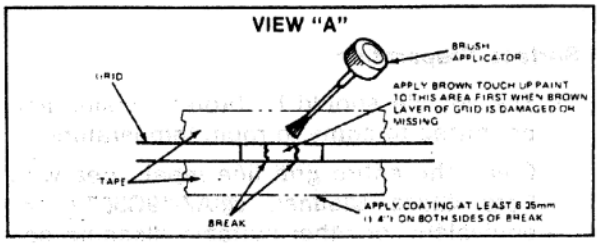
LEAD WIRE TERMINAL SERVICE

1. Allow the rear window to warm up to room temperature for a half hour to an hour.
2. Clean the bus bar in the area to be serviced using fine steel wool (3/0 to 4/0 grade).



3. Restore the area where the bus bar terminal was originally attached by applying three coats of D8AZ-19562-A, or equivalent, Grid Repair Compound. Allow approximately ten minutes drying time between coats.

USING CELLULOSE TAPE, MASK OFF THE AREA DIRECTLY ABOVE AND BELOW THE GRID BREAK. THE BREAK AREA SHOULD BE AT THE CENTER OF THE MASK AND THE TAPE GAP MUST BE NO WIDER THAN THE EXISTING GRID LINE.



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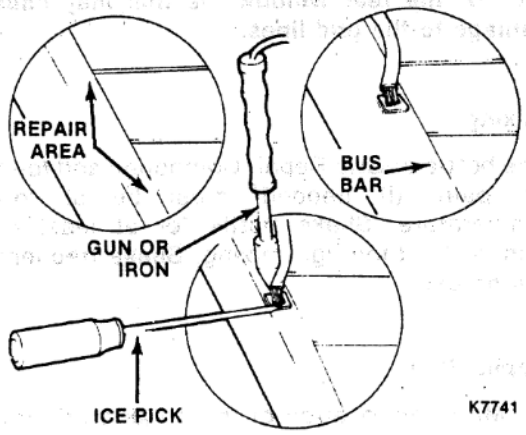
4. Working as quickly as possible to avoid overheating the glass, tin the bus bar with solder in the area where the terminal will be attached.
5. Prior to soldering the terminal on, use a heat gun or heat lamp to pre-heat the glass in the solder area to 50-60°C (120-150°F).

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6. Position the terminal on the bus bar in the area that was tinned and hold it in place with an ice pick or screwdriver.
7. Apply soldering heat to the pad of the terminal until the solder flows.

NOTE: To avoid damaging the bus bar, remove the soldering gun or iron as soon as the solder flows.

8. Start the vehicle. Turn the heated window ON and leave it on for five minutes. Inspect the terminal and apply D8AZ-19562-A, or equivalent, Grid Repair Compound to the required area.



K7741

SPEED CONTROL

GROUP 37 (9000)

TITLE SECTION	PAGE NO.	TITLE SECTION	PAGE NO.

SPEED CONTROL DIAGNOSIS 37-01

GENERAL INFORMATION 1
TROUBLESHOOTING CHART 2
DIAGNOSTIC CHART 4
ELECTRICAL SCHEMATIC 28

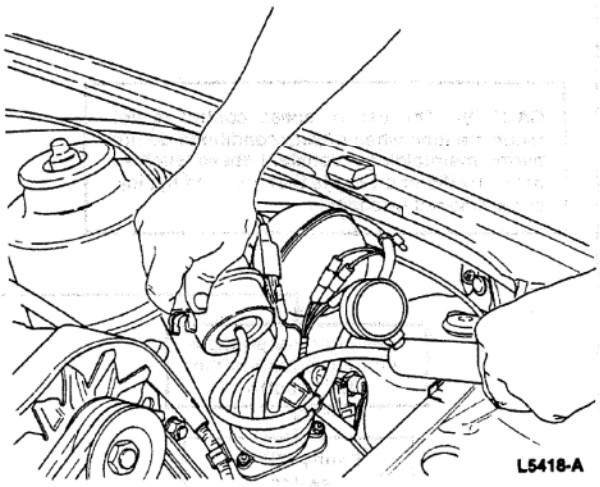
SPEED CONTROL 37-06

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REMOVAL AND INSTALLATION
- ON/OFF Switch 2
- Speed Sensor 2
- Set/Decel Switch 3
- Vacuum Valve Assembly 3
- Clutch/Brake Override Switches 4
- Amplifier 5
- Servo Cable 6
- Vacuum Servo 7

SECTION 37-01 SPEED CONTROL DIAGNOSIS

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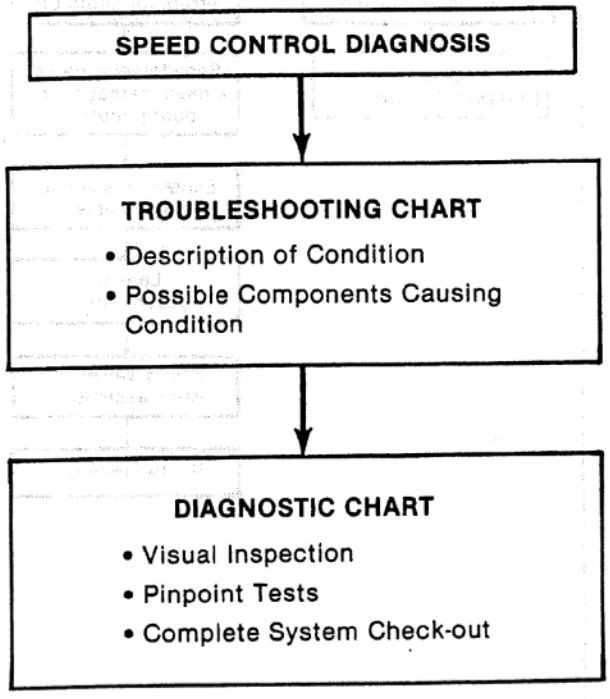
GENERAL INFORMATION

This section is divided into two separate charts —a troubleshooting chart and a diagnostic chart. The troubleshooting chart is used to diagnose specific conditions as they would be described by an owner. The diagnostic chart contains a step-by-step check of the entire speed control system.

Speed control diagnostics should begin with the troubleshooting chart. From the chart, a description of the condition and possible causative components can be determined.

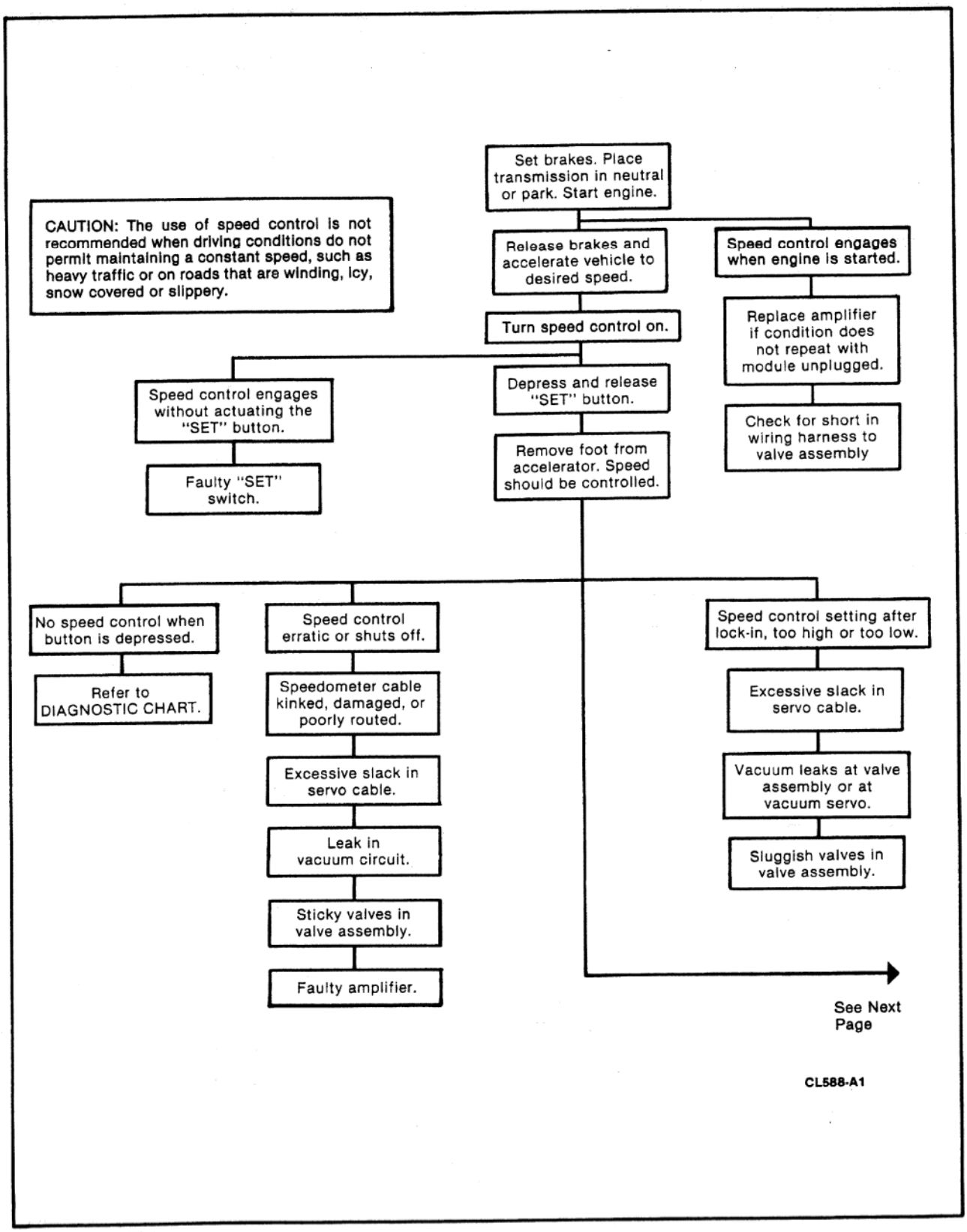
Once the condition has been defined, specific procedures in the diagnostic chart can be used to isolate the cause to a specific component, electrical circuit or vacuum circuit.

The diagnostic chart can also be used to perform a complete check-out of the speed control system. Beginning with a visual inspection, the chart proceeds through 27 additional tests that not only check each component but also check the interconnecting wiring and vacuum circuits.



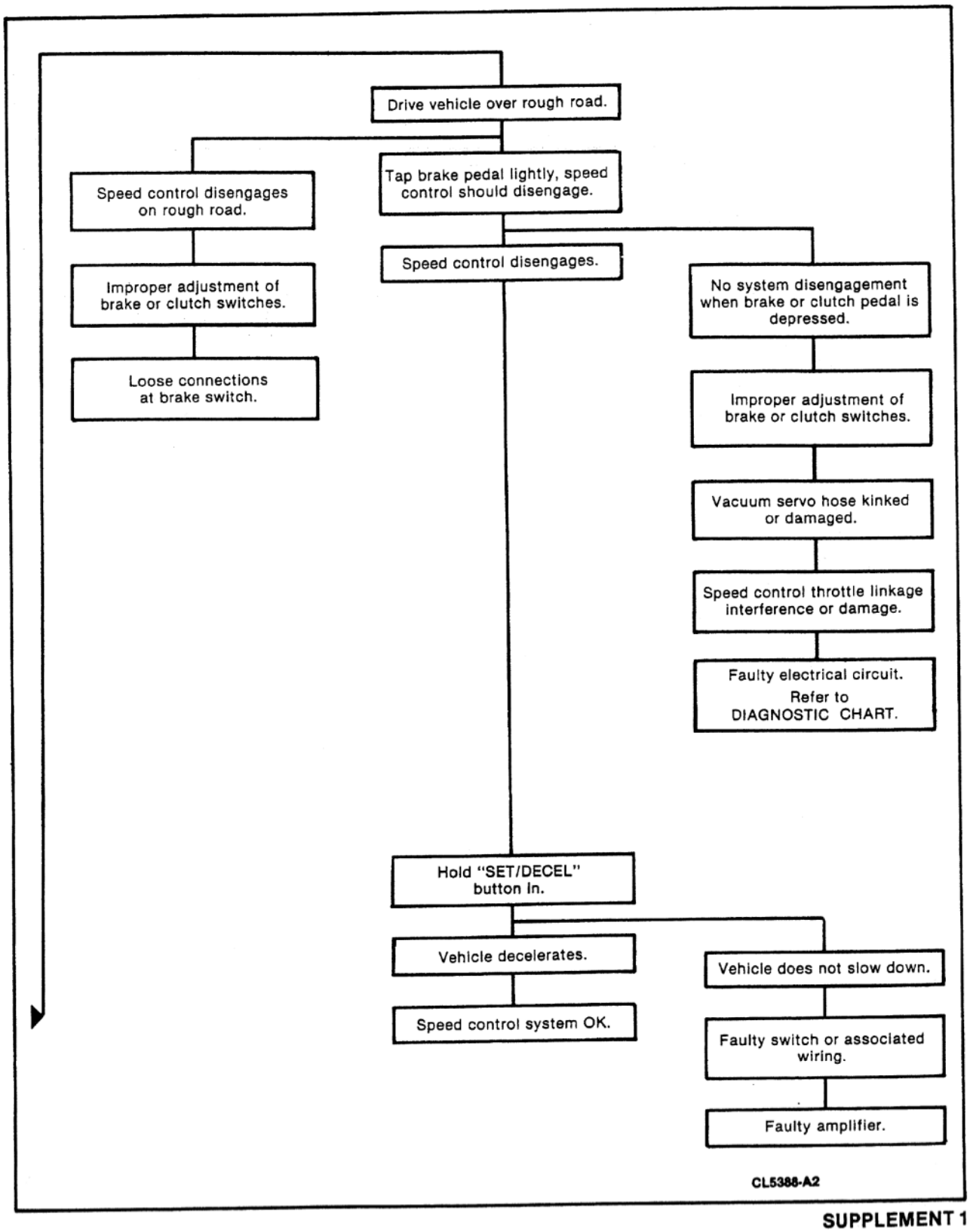
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TROUBLESHOOTING CHART



SUPPLEMENT 1

TROUBLESHOOTING CHART (Continued)



SUPPLEMENT 1

DIAGNOSTIC CHART

SPEED CONTROL DIAGNOSTIC CHART

NOTE: The following diagnostic procedures contain mechanical and electrical tests of the speed control components. Although not specifically stated, it is assumed the ignition and speed control switches are in the ON position during all electrical tests.

1 VISUAL INSPECTION

TEST STEP	RESULTS	ACTION TO TAKE
• Carefully check each vacuum hose and vacuum hose connection. — Source to reservoir — Reservoir to valve assembly — Valve assembly to vacuum tee — Vacuum tee to servo — Vacuum tee to dump valve(s) — Dump valves. • Carefully check each electrical connection. — Valve assembly — ON/OFF switch — Brake switch — Clutch switch (if equipped) — Amplifier — Set switch	NO REPAIRS REQUIRED REPAIRS REQUIRED	SYSTEM HAS PASSED VISUAL INSPECTION. Proceed to next test. SYSTEM HAS NOT PASSED VISUAL INSPECTION. Make necessary repairs.

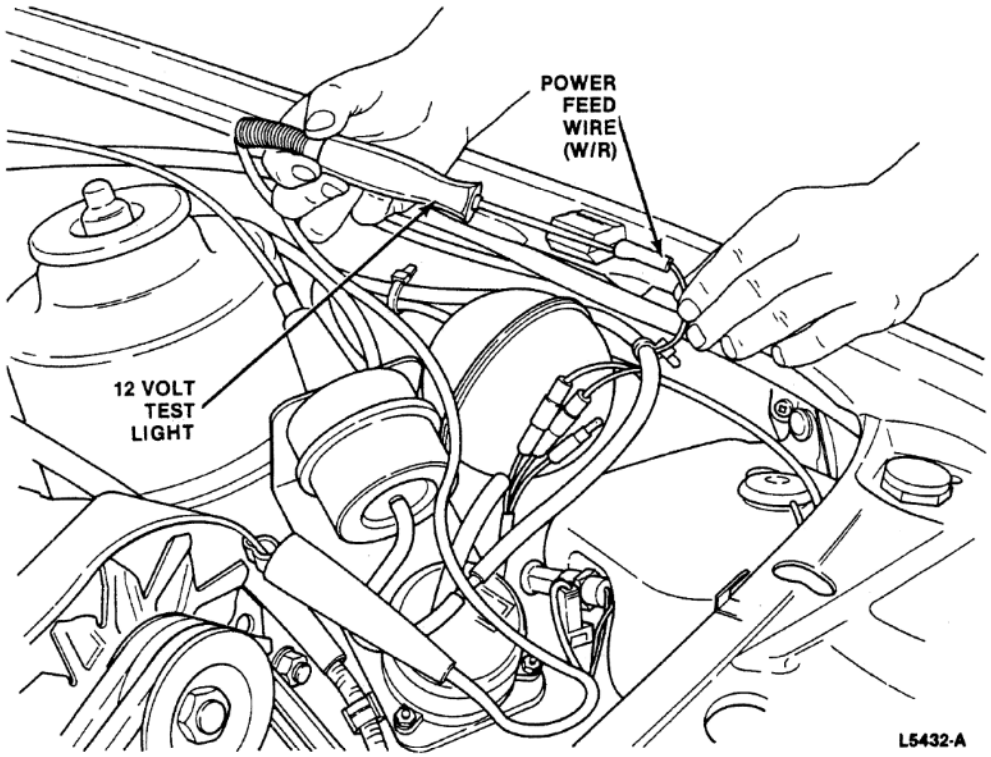
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DIAGNOSTIC CHART (Continued)

SPEED CONTROL DIAGNOSTIC CHART (Continued)

2 POWER FEED TO SERVO

TEST STEP	RESULTS	ACTION TO TAKE
• Disconnect white/red wire at power servo. • Using a test light or voltmeter, check for voltage at servo power feed wire (W/R).	BATTERY VOLTAGE	POWER FEED TO SERVO IS OK. Proceed to next test.
	NO BATTERY VOLTAGE	POWER FEED TO SERVO IS NOT OK. Proceed to test 26.



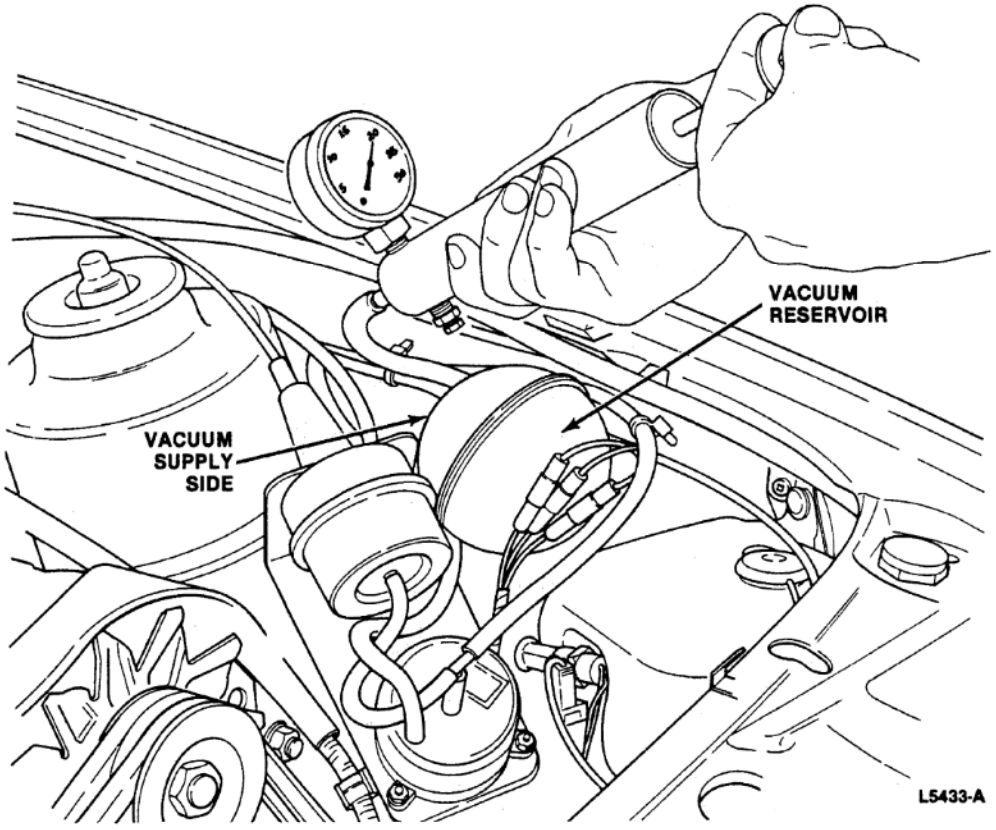
CL5417-A2

DIAGNOSTIC CHART (Continued)

SPEED CONTROL DIAGNOSTIC CHART (Continued)

3 VACUUM SUPPLY LEAK TEST

TEST STEP	RESULTS	ACTION TO TAKE
• Disconnect hose from vacuum reservoir fitting marked "VAC."	VACUUM HOLDS	VACUUM SUPPLY SYSTEM IS NOT LEAKING. Proceed to test 7.
• Using a hand vacuum pump, apply 20″ of vacuum through "VAC" hose fitting.	VACUUM DOES NOT HOLD	VACUUM SUPPLY SYSTEM IS LEAKING. Proceed to next test.



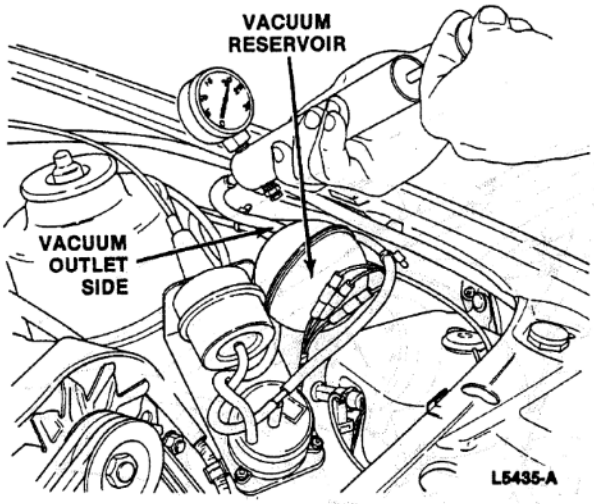
CL5417-A3

DIAGNOSTIC CHART (Continued)

SPEED CONTROL DIAGNOSTIC CHART (Continued)

4 VACUUM RESERVOIR LEAK TEST

TEST STEP	RESULTS	ACTION TO TAKE
• Disconnect hose from reservoir vacuum outlet fitting. • Plug reservoir vacuum outlet fitting. • Using a hand vacuum pump, apply 20″ of vacuum to reservoir through "VAC" hose fitting.	VACUUM HOLDS	VACUUM RESERVOIR IS NOT LEAKING. Proceed to next test.
	VACUUM DOES NOT HOLD	VACUUM RESERVOIR IS LEAKING. Replace reservoir. (Then perform test 3 again.)



5 VACUUM RESERVOIR CHECK VALVE TEST

TEST STEP	RESULTS	ACTION TO TAKE
• Using a hand vacuum pump, apply 20″ of vacuum to reservoir through outlet fitting.	VACUUM HOLDS	RESERVOIR CHECK VALVE IS NOT LEAKING. Proceed to next test.
	VACUUM DOES NOT HOLD	RESERVOIR CHECK VALVE IS LEAKING. Replace reservoir. (Then perform test 3 again.)

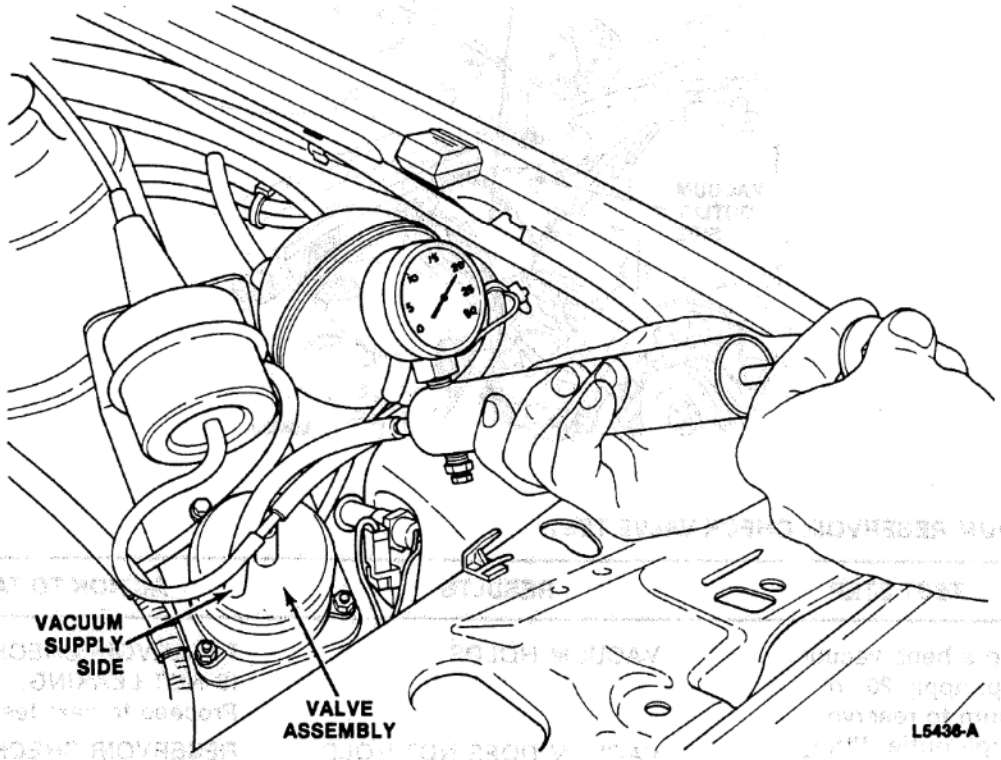
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DIAGNOSTIC CHART (Continued)

SPEED CONTROL DIAGNOSTIC CHART (Continued)

6 VACUUM VALVE LEAK TEST

TEST STEP	RESULTS	ACTION TO TAKE
• Disconnect hose from valve assembly fitting marked "VAC."	VACUUM HOLDS	VACUUM VALVE IS NOT LEAKING. Proceed to next test.
• Using a hand vacuum pump, apply 20″ of vacuum to valve through "VAC" hose fitting.	VACUUM DOES NOT HOLD	VACUUM VALVE IS LEAKING. Replace valve assembly.



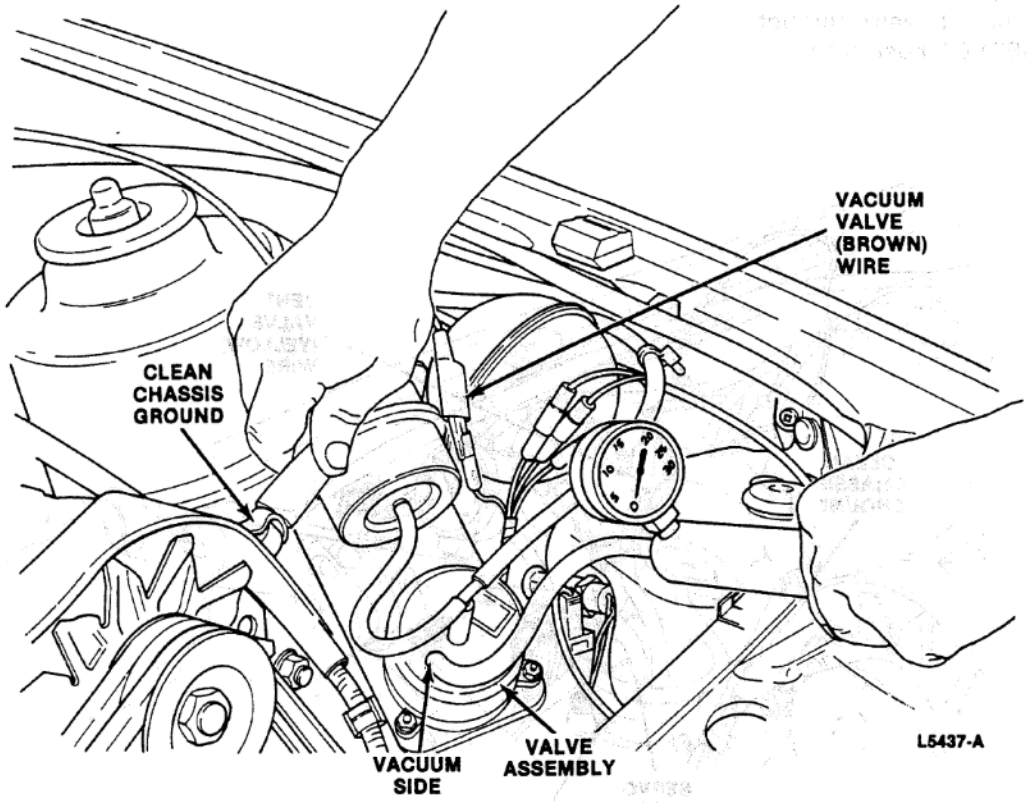
CL5417-A5

DIAGNOSTIC CHART (Continued)

SPEED CONTROL DIAGNOSTIC CHART (Continued)

7 VACUUM VALVE ELECTRICAL TEST

TEST STEP	RESULTS	ACTION TO TAKE
• Disconnect brown wire at power servo. • Using a hand vacuum pump, apply 20″ of vacuum to valve through "VAC" hose fitting. • Connect a jumper wire from a clean chassis ground to brown wire at valve assembly.	VACUUM VENTS	VACUUM VALVE FUNCTIONS ELECTRICALLY. Proceed to next test.
	VACUUM DOES NOT VENT	VACUUM VALVE IS NOT FUNCTIONING ELECTRICALLY. Replace valve assembly.



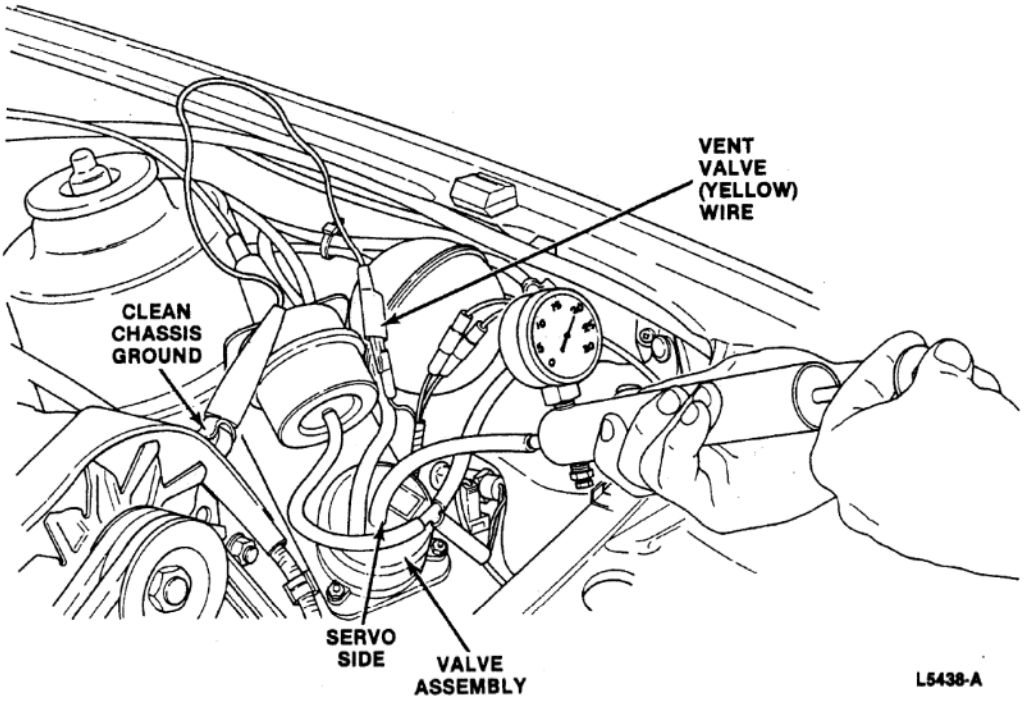
CL5417-A6

DIAGNOSTIC CHART (Continued)

SPEED CONTROL DIAGNOSTIC CHART (Continued)

8 SERVO VALVE ELECTRICAL/LEAK TEST

TEST STEP	RESULTS	ACTION TO TAKE
• Disconnect hose from valve assembly fitting marked "SERVO."	VACUUM HOLDS	SERVO VALVE FUNCTIONS ELECTRICALLY AND IS NOT LEAKING. Proceed to next test.
• Disconnect yellow wire at power servo. • Connect a jumper wire from a clean chassis ground to yellow wire at valve assembly. • Using a hand vacuum pump, apply 20″ of vacuum to valve through "SERVO" hose fitting.	VACUUM DOES NOT HOLD	SERVO VALVE IS NOT FUNCTIONING ELECTRICALLY AND/OR IS LEAKING. Replace valve assembly.



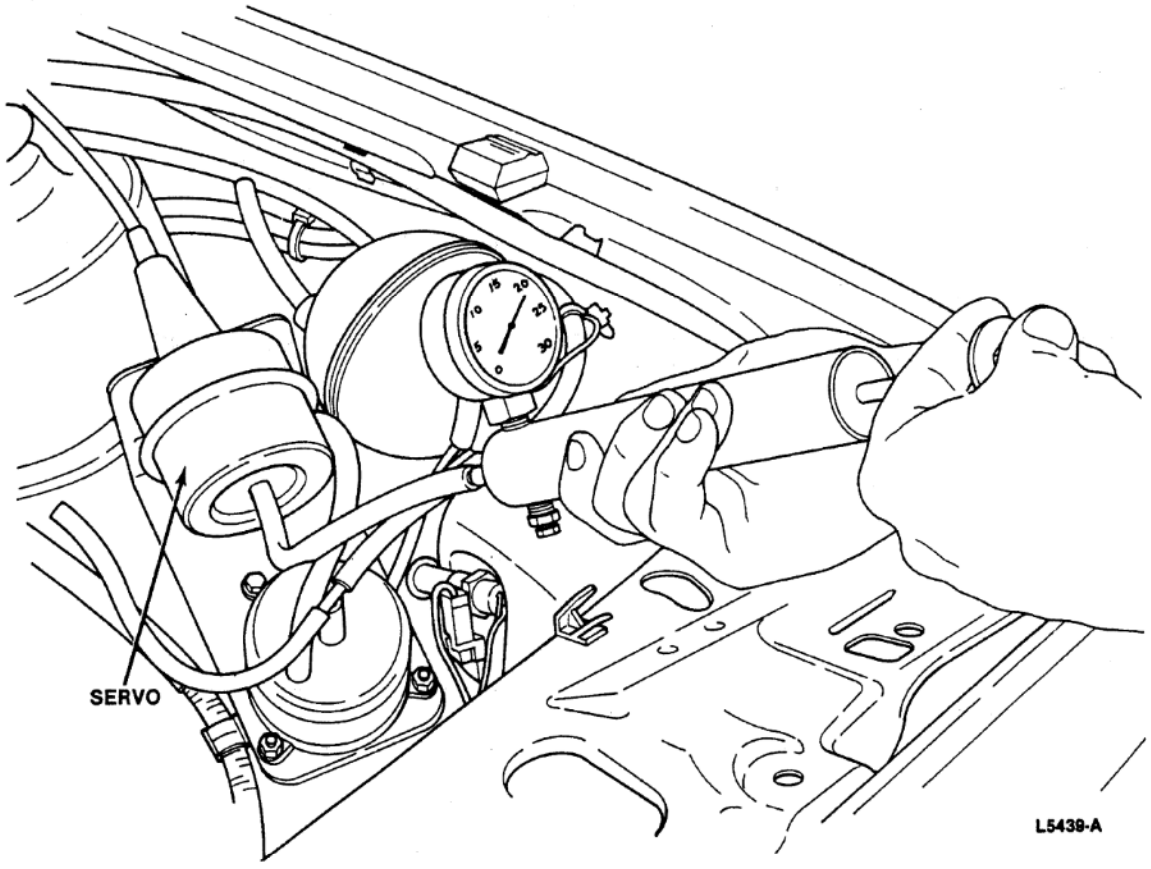
CL5417-A7

DIAGNOSTIC CHART (Continued)

SPEED CONTROL DIAGNOSTIC CHART (Continued)

9 SERVO LEAK TEST

TEST STEP	RESULTS	ACTION TO TAKE
• Disconnect hose from vacuum servo.	VACUUM HOLDS	SERVO IS NOT LEAKING. Proceed to next test.
• Using a hand vacuum pump, apply 20″ of vacuum to servo through hose fitting.	VACUUM DOES NOT HOLD	SERVO IS LEAKING. Replace servo.



CL5417-A8

DIAGNOSTIC CHART (Continued)

SPEED CONTROL DIAGNOSTIC CHART (Continued)

10 LINKAGE/SERVO CABLE TEST

TEST STEP	RESULTS	ACTION TO TAKE
• Using a hand vacuum pump, apply 20″ of vacuum to servo through hose fitting. • While applying vacuum, watch the throttle lever and servo cable.	THROTTLE LEVER MOVES SMOOTHLY TO WIDE OPEN POSITION	LINKAGE/CABLE IS OPERATING PROPERLY. Proceed to test 13.
	THROTTLE LEVER DOES NOT MOVE OR BINDS	LINKAGE/CABLE IS NOT OPERATING PROPERLY. Proceed to next test.

11 THROTTLE CABLE TEST

TEST STEP	RESULTS	ACTION TO TAKE
• Disconnect speed control cable from throttle lever. If necessary, refer to cable removal and installation procedure in Section 37-06. • Using a hand vacuum pump, apply 20″ of vacuum to servo through hose fitting.	CABLE MOVES SMOOTHLY	CABLE IS OPERATING PROPERLY. Proceed to next test.
	CABLE DOES NOT MOVE OR BINDS	CABLE IS NOT OPERATING PROPERLY. Find cause and correct or replace cable.

12 THROTTLE LEVER TEST

TEST STEP	RESULTS	ACTION TO TAKE
• With the speed control cable disconnected, move the throttle lever from the idle position to wide open position.	LEVER MOVES SMOOTHLY	THROTTLE LINKAGE IS OPERATING PROPERLY. Proceed to next test.
	LEVER DOES NOT MOVE SMOOTHLY	THROTTLE LINKAGE IS NOT OPERATING PROPERLY. Isolate cause and repair as necessary.

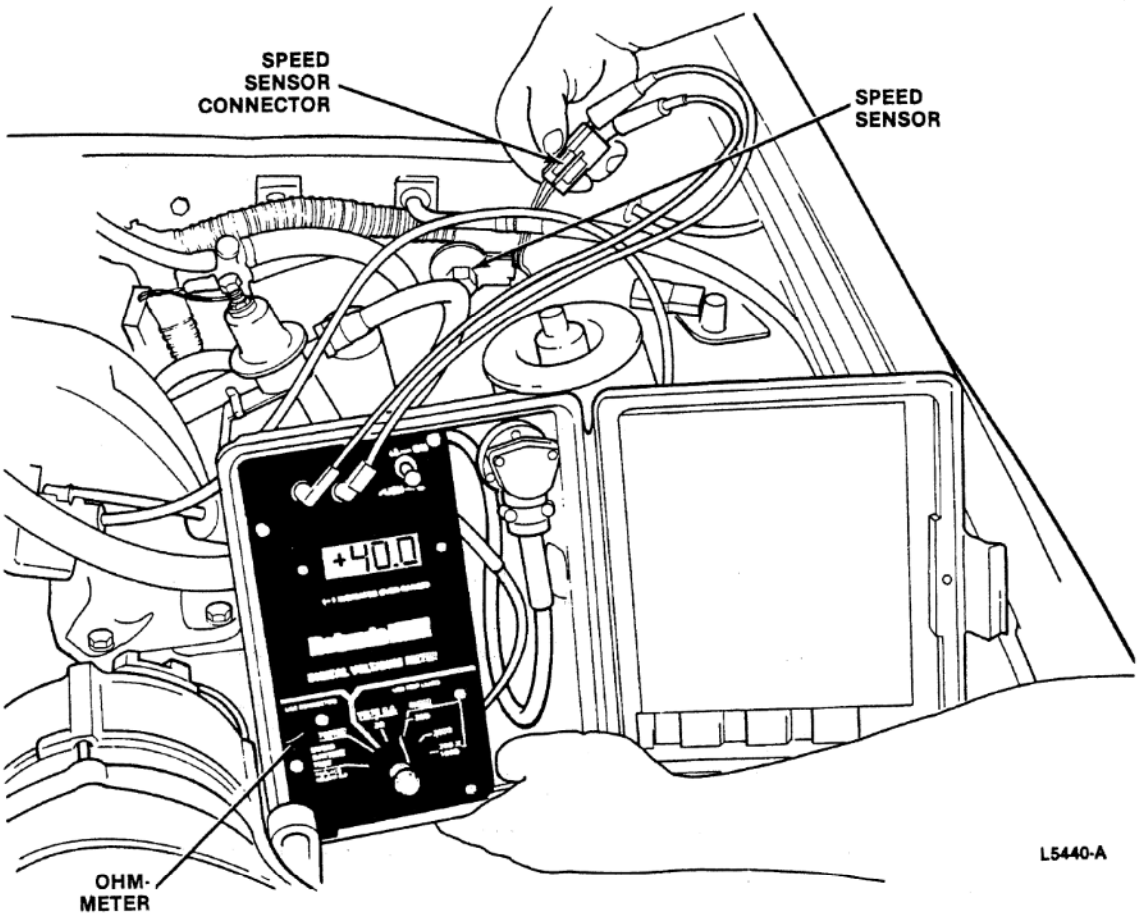
CL5417-A9

DIAGNOSTIC CHART (Continued)

SPEED CONTROL DIAGNOSTIC CHART (Continued)

13 SPEED SENSOR

TEST STEP	RESULTS	ACTION TO TAKE
• Disconnect wiring connector from speed sensor. • Using an ohmmeter, measure resistance of speed sensor.	40 OHMS ±5 OHMS	SPEED SENSOR CIRCUIT IS OK. Repair cause of high or low resistance in sensor circuit.
	MORE THAN 45 OHMS OR LESS THAN 35 OHMS	SPEED SENSOR IS NOT OK. Replace sensor.



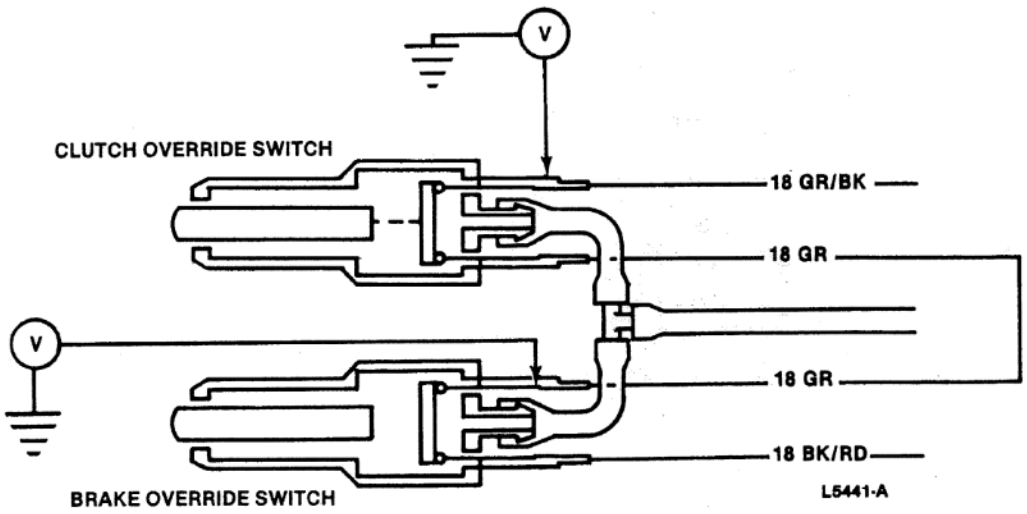
CL5417-A10

DIAGNOSTIC CHART (Continued)

SPEED CONTROL DIAGNOSTIC CHART (Continued)

14 BRAKE/CLUTCH OVERRIDE CIRCUIT

TEST STEP	RESULTS	ACTION TO TAKE
AUTOMATIC TRANSMISSION • Using a voltmeter, measure voltage at brake override switch terminal (GR).	LESS THAN ONE VOLT	BRAKE/CLUTCH OVERRIDE CIRCUIT OK. Proceed to next test.
	APPROXIMATELY FIVE VOLTS	BRAKE CLUTCH OVERRIDE CIRCUIT IS NOT OK. Repair open in circuit. Check the following: • Jumper (G) from clutch to brake switch (if equipped) • Brake switch • Clutch switch (if equipped) • Circuit B2 (BK/RD)
MANUAL TRANSMISSION • Using a voltmeter, measure voltage at clutch override switch terminal (GR/BK).	ZERO VOLTS	BRAKE/CLUTCH OVERRIDE CIRCUIT IS NOT OK. Repair open in circuit A2 (GR/BK).



CL5417-A11

SUPPLEMENT 1

DIAGNOSTIC CHART (Continued)

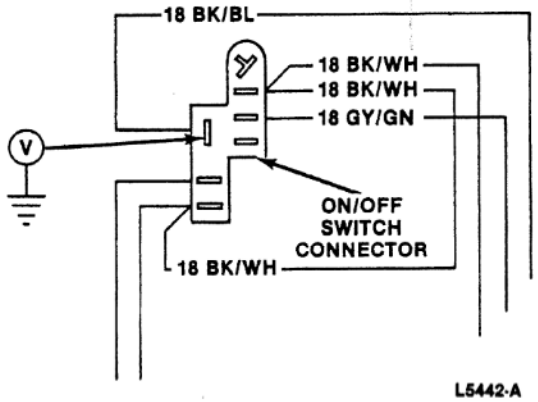
SPEED CONTROL DIAGNOSTIC CHART (Continued)

15 AMPLIFIER BRAKE/CLUTCH OVERRIDE CIRCUIT SIGNAL

TEST STEP	RESULTS	ACTION TO TAKE
AUTOMATIC TRANSMISSION • Press and hold brake pedal. • While holding brake pedal, measure voltage at brake switch terminal (GR).	APPROXIMATELY FIVE VOLTS	AMPLIFIER IS PROVIDING BRAKE/CLUTCH OVERRIDE SIGNAL. Proceed to next test.
	VOLTAGE IS NOT APPROXIMATELY FIVE VOLTS	AMPLIFIER IS NOT PROVIDING BRAKE/CLUTCH OVERRIDE SIGNAL. Replace amplifier.
MANUAL TRANSMISSION • Press clutch pedal approximately one inch. • While holding clutch pedal, measure voltage at clutch switch terminal (GR/BK).		

16 POWER FEED TO ON/OFF SWITCH

TEST STEP	RESULTS	ACTION TO TAKE
• Using a test light or voltmeter, check for voltage at ON/OFF switch ignition terminal (BK/BL).	BATTERY VOLTAGE	POWER FEED TO SWITCH IS OK. Proceed to next test.
	NO BATTERY VOLTAGE	POWER FEED TO SWITCH IS NOT OK. Repair open in wire to switch from ignition feed source.



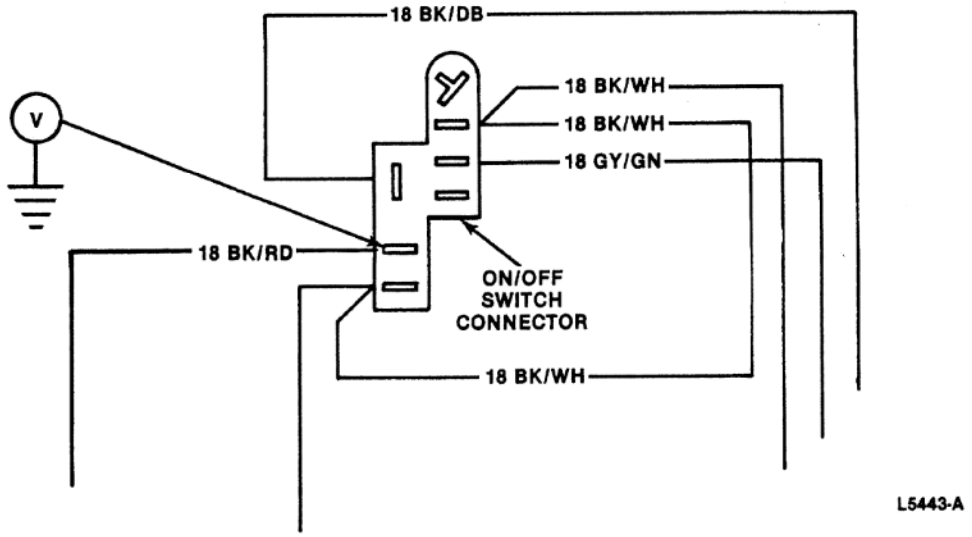
L5442-A CL5417-A12

DIAGNOSTIC CHART (Continued)

SPEED CONTROL DIAGNOSTIC CHART (Continued)

17 POWER FEED FROM ON/OFF SWITCH TO AMPLIFIER

TEST STEP	RESULTS	ACTION TO TAKE
• Using a test light or voltmeter, check for battery voltage at ON/OFF switch amplifier terminal (BK/RD).	BATTERY VOLTAGE	POWER FEED FROM SWITCH TO AMPLIFIER IS OK. Proceed to next test.
	NO BATTERY VOLTAGE	POWER FEED FROM SWITCH TO AMPLIFIER IS NOT OK. Replace ON/OFF switch.



CL5417-A13

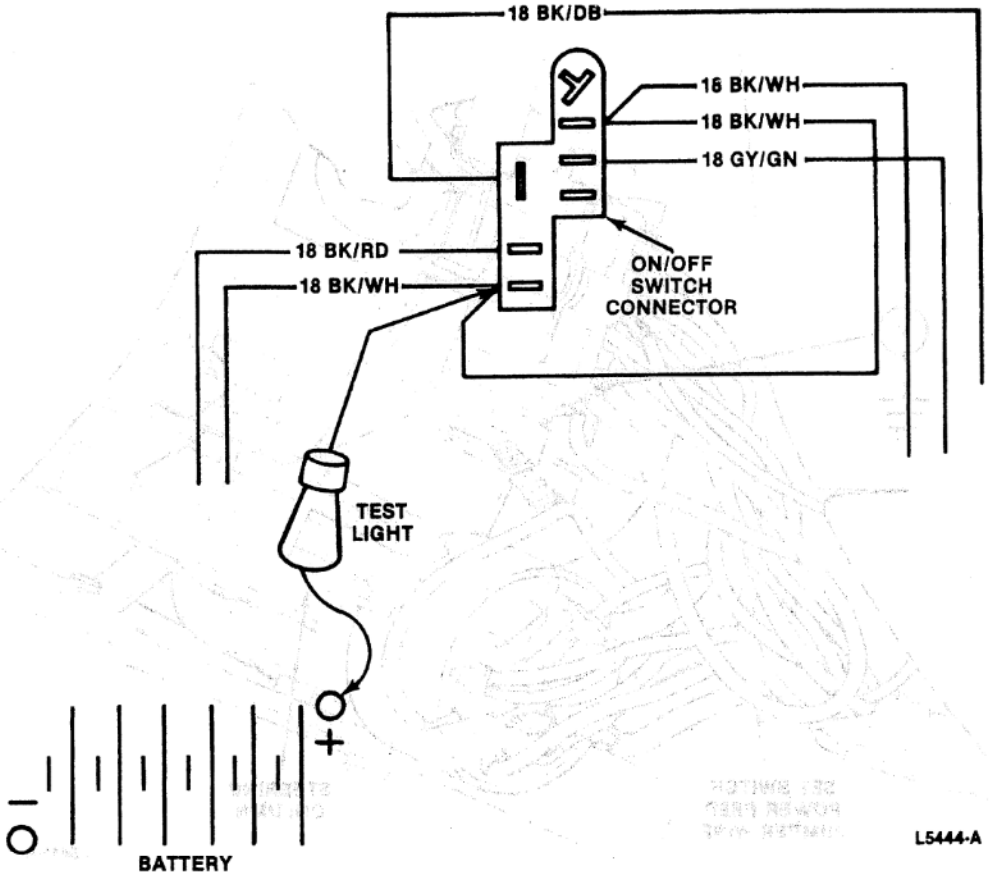
SUPPLEMENT 1

DIAGNOSTIC CHART (Continued)

SPEED CONTROL DIAGNOSTIC CHART (Continued)

18 SWITCH GROUND CONNECTIONS

TEST STEP	RESULTS	ACTION TO TAKE
• Connect test light clamp to a convenient source of battery voltage.	TEST LIGHT ON	GROUND CIRCUITS AT SWITCH ARE OK. Proceed to next test.
• Touch probe end of test light to ground wire connections at ON/OFF switch (BK/WH).	TEST LIGHT DOES NOT COME ON	GROUND CIRCUITS AT SWITCH ARE NOT OK. Repair open in ground circuit.



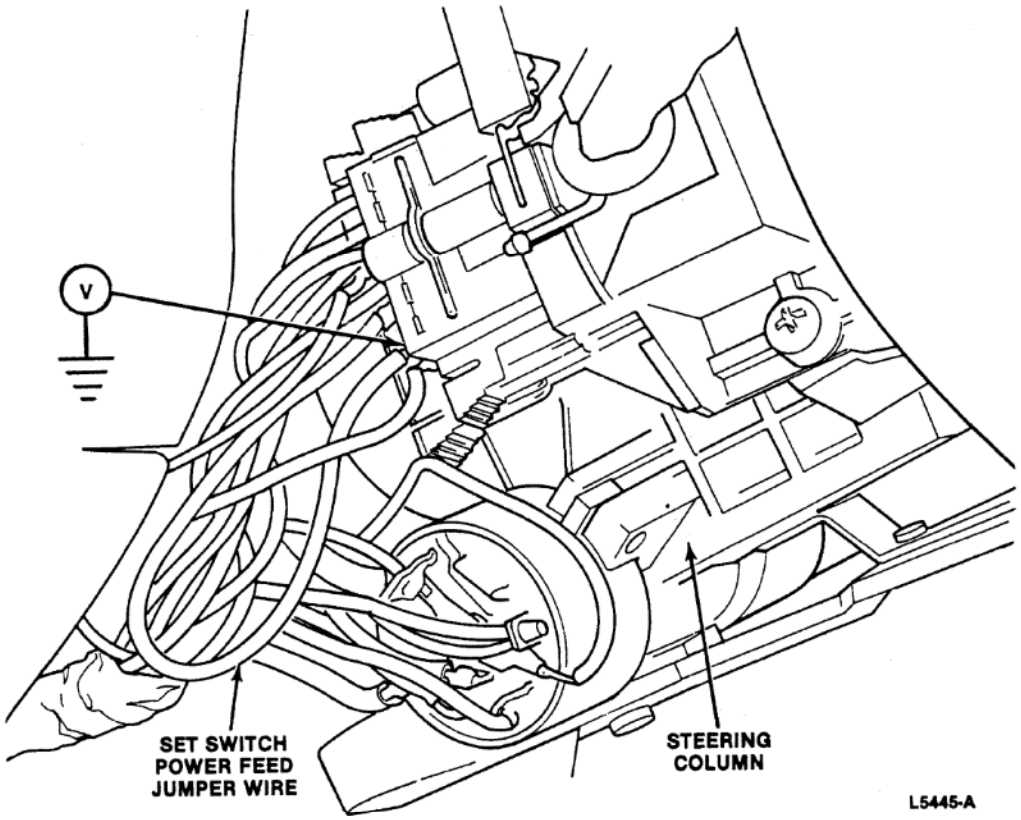
CL5417-A14

DIAGNOSTIC CHART (Continued)

SPEED CONTROL DIAGNOSTIC CHART (Continued)

19 POWER FEED TO SET SWITCH

TEST STEP	RESULTS	ACTION TO TAKE
• Remove steering column lower trim cover. • Using a test light or voltmeter, check for voltage at jumper wire supplying battery voltage to switch.	BATTERY VOLTAGE	POWER FEED CIRCUIT TO SWITCH IS OK. Proceed to next test.
	NO BATTERY VOLTAGE	POWER FEED TO SWITCH IS NOT OK. Repair open in jumper wire.



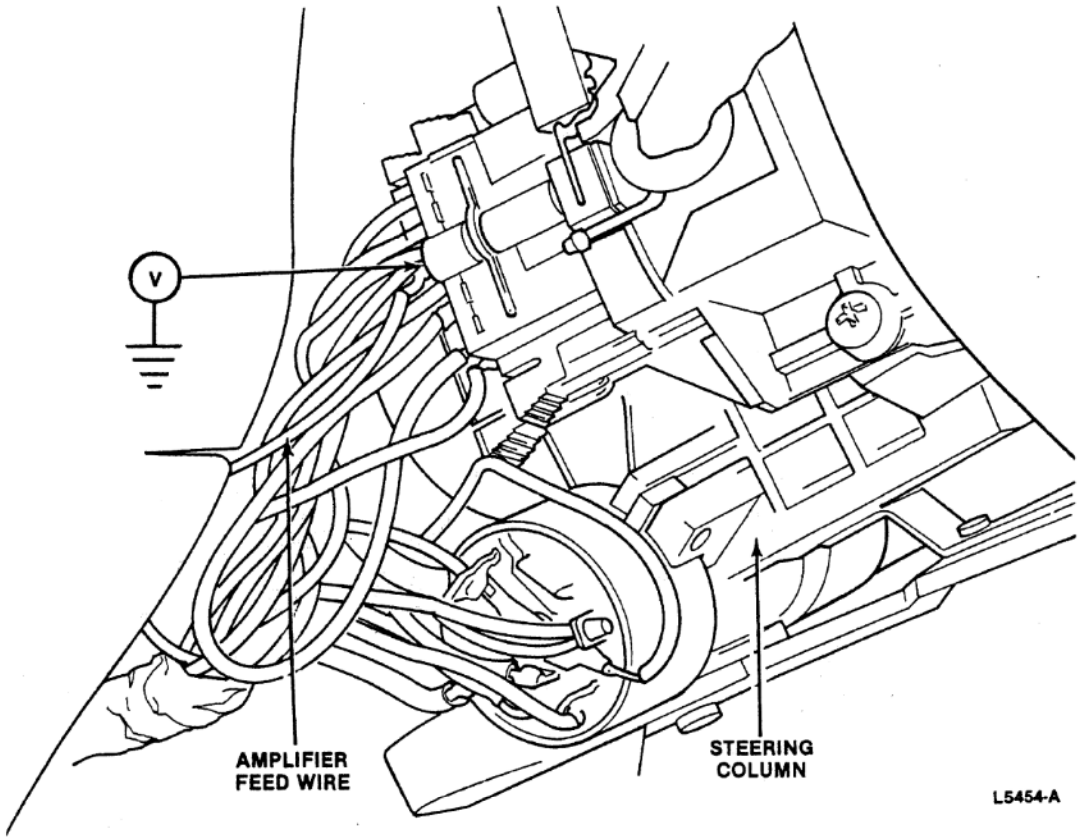
CL5417-A15

DIAGNOSTIC CHART (Continued)

SPEED CONTROL DIAGNOSTIC CHART (Continued)

20 POWER FEED FROM SET SWITCH TO AMPLIFIER

TEST STEP	RESULTS	ACTION TO TAKE
• While holding the set switch in, check for voltage at amplifier feed terminal using a voltmeter or test light.	BATTERY VOLTAGE	POWER FEED FROM SWITCH TO AMPLIFIER IS OK. Proceed to next test.
	NO BATTERY VOLTAGE	POWER FEED FROM SWITCH TO AMPLIFIER IS NOT OK. Replace switch.



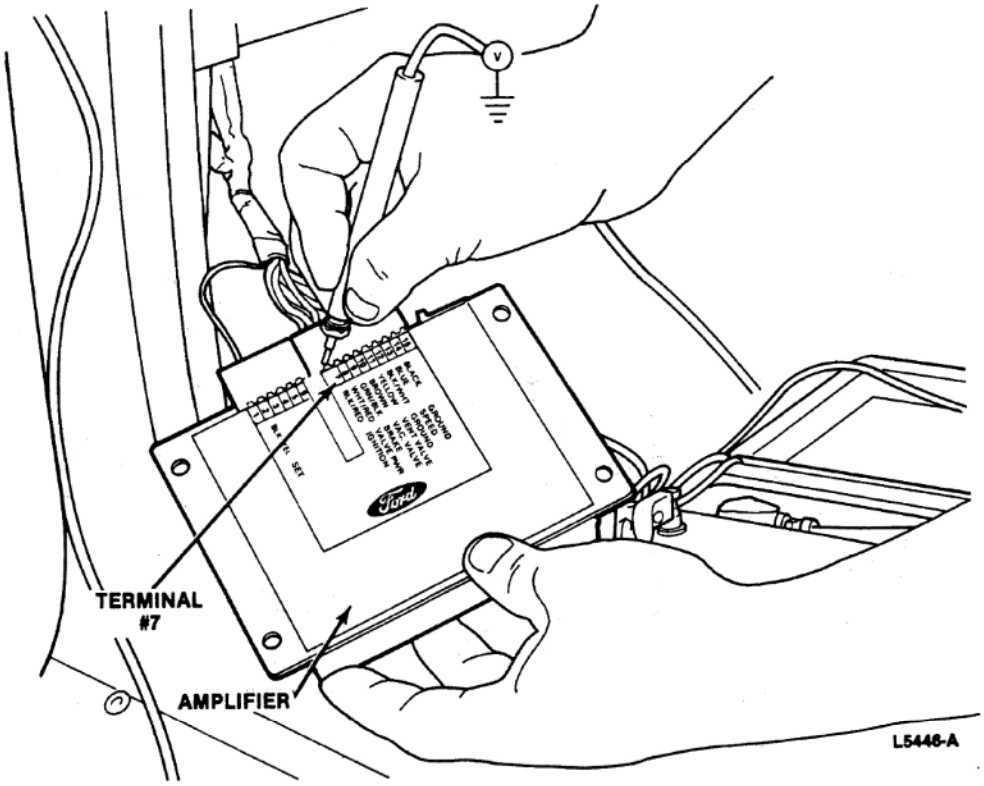
CL5417-A16

DIAGNOSTIC CHART (Continued)

SPEED CONTROL DIAGNOSTIC CHART (Continued)

21 POWER FEED TO AMPLIFIER FROM ON/OFF SWITCH

TEST STEP	RESULTS	ACTION TO TAKE
• Remove amplifier attaching screws and lower into an accessible position. (Amplifier removal procedure is included in Section 37-06.) • Be sure wiring is securely connected to amplifier. • Using a test light or voltmeter, check for battery voltage at amplifier pin 7 (IGNITION BK/RD).	BATTERY VOLTAGE	POWER FEED FROM SWITCH TO AMPLIFIER IS OK. Proceed to next test.
	NO BATTERY VOLTAGE	POWER FEED FROM SWITCH TO AMPLIFIER IS NOT OK. Repair open in wire from switch to amplifier.



CL5417-A17

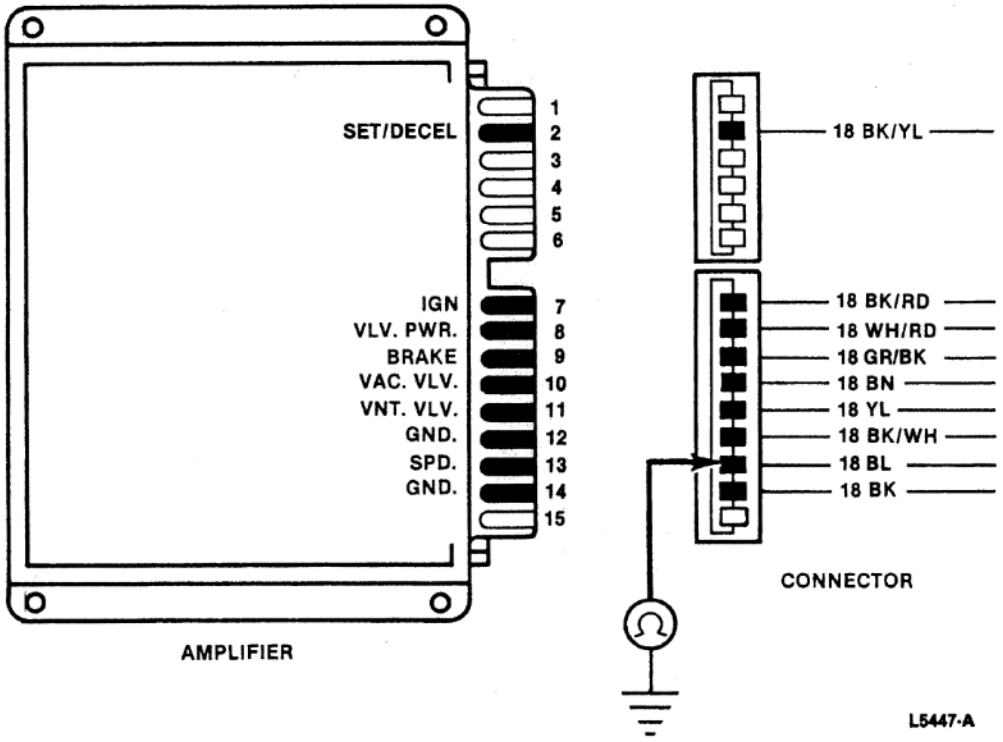
SUPPLEMENT 1

DIAGNOSTIC CHART (Continued)

SPEED CONTROL DIAGNOSTIC CHART (Continued)

22 SPEED SENSOR CIRCUIT

TEST STEP	RESULTS	ACTION TO TAKE
• Disconnect wiring connector from amplifier. • Using an ohmmeter measure resistance between pin 13 (BL) and a clean chassis ground.	40 OHMS ±5 OHMS	SPEED SENSOR CIRCUIT IS OK. Proceed to next test.
	MORE THAN 45 OHMS OR LESS THAN 35 OHMS	SPEED SENSOR CIRCUIT IS NOT OK. Repair open or ground in sensor circuit.



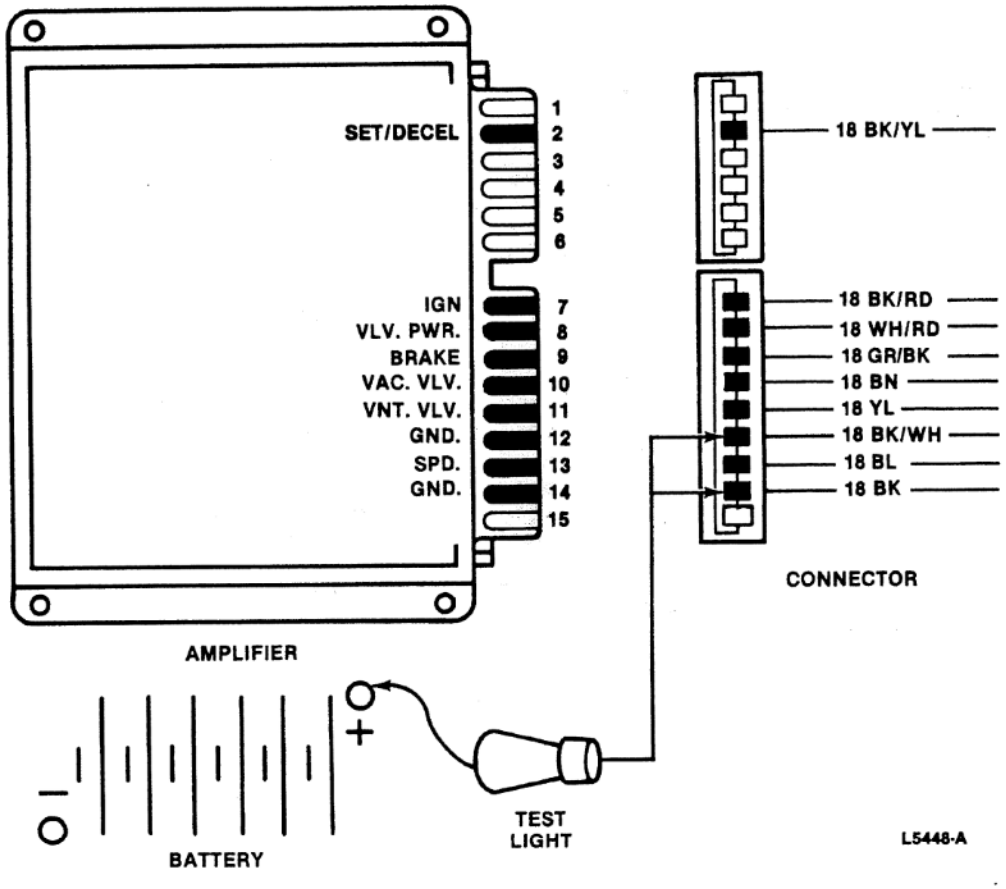
CL5417-A18

DIAGNOSTIC CHART (Continued)

SPEED CONTROL DIAGNOSTIC CHART (Continued)

23 AMPLIFIER GROUND CIRCUITS

TEST STEP	RESULTS	ACTION TO TAKE
• Connect test light clamp to a convenient source of battery voltage. • Touch probe end of test light to terminal 14 (GND.-BK) and 12 (GND.-BK/WH) at the amplifier connector.	TEST LIGHT ON AT BOTH TERMINALS TEST LIGHT OFF AT EITHER OR BOTH TERMINALS	GROUND CIRCUIT IS OK. Proceed to next test. GROUND CIRCUIT IS NOT OK. Repair open in ground circuit.



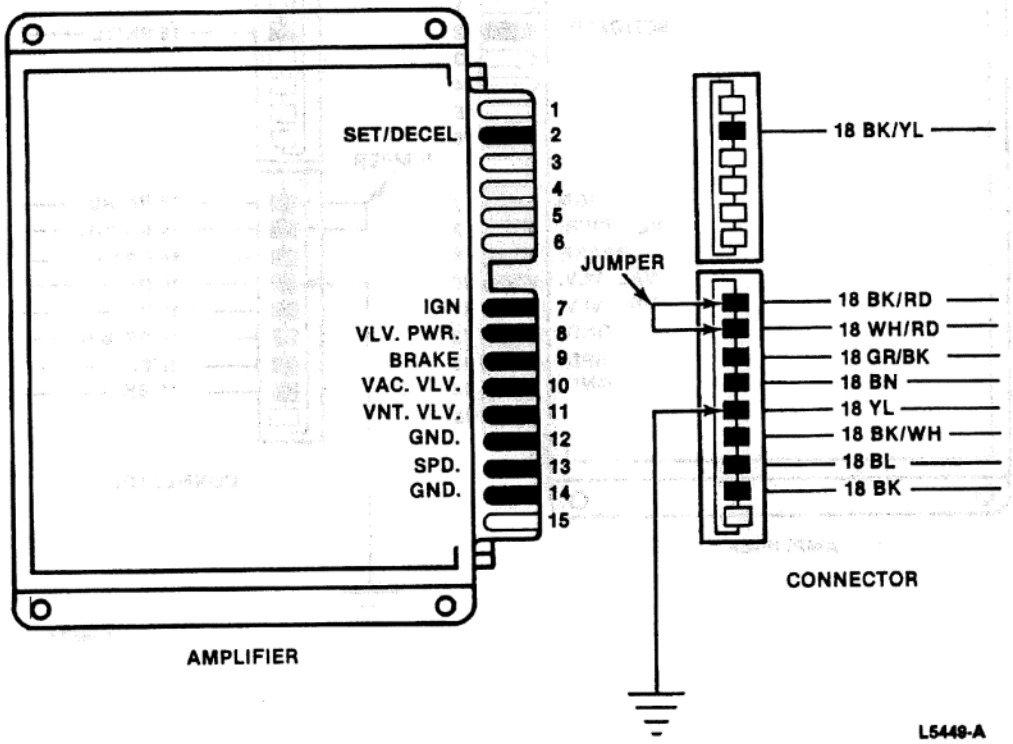
CL5417-A19

DIAGNOSTIC CHART (Continued)

SPEED CONTROL DIAGNOSTIC CHART (Continued)

24 VENT VALVE CIRCUIT

TEST STEP	RESULTS	ACTION TO TAKE
• Disconnect wiring from amplifier. • Connect a jumper wire from terminal 7 (ING-BK/RD) to terminal 8 (VLV. PWR.-WH/RD). • Connect a jumper from a clean chassis ground to terminal 11 (VNT. VLV.-YL). • Make and break connection several times to confirm results.	VALVE CLICKS	VENT VALVE CIRCUIT IS OK. Leave jumper wire connected and proceed to next test.
	VALVE DOES NOT CLICK	VENT VALVE CIRCUIT IS NOT OK. Repair open in wire from amplifier to valve assembly.



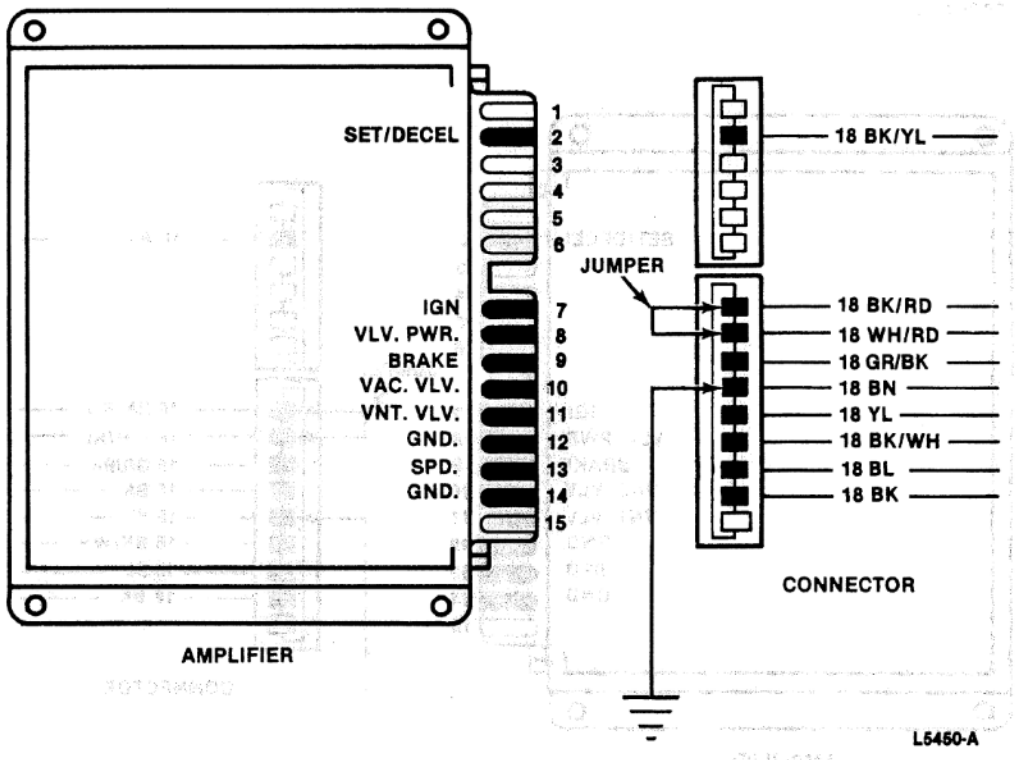
CL5417-A20

DIAGNOSTIC CHART (Continued)

SPEED CONTROL DIAGNOSTIC CHART (Continued)

25 VACUUM VALVE CIRCUIT

TEST STEP	RESULTS	ACTION TO TAKE
• Connect jumper wire from clean chassis ground to terminal 10 (VAC. VLV.-BN). • Make and break connection several times to confirm results.	VALVE CLICKS	VACUUM VALVE CIRCUIT IS OK. Proceed to next test.
	VALVE DOES NOT CLICK	VACUUM VALVE CIRCUIT IS NOT OK. Repair open in wire from amplifier to valve assembly.



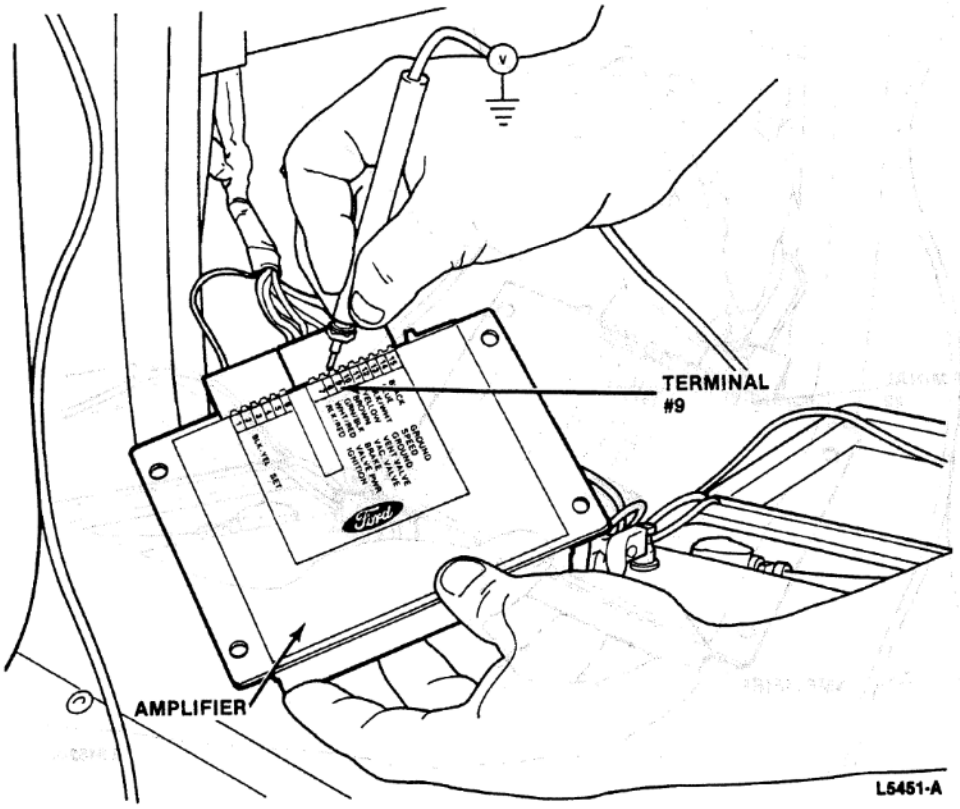
CL5417-A21

DIAGNOSTIC CHART (Continued)

SPEED CONTROL DIAGNOSTIC CHART (Continued)

26 BRAKE/CLUTCH OVERRIDE SIGNAL

TEST STEP	RESULTS	ACTION TO TAKE
• Be sure wiring is firmly connected to amplifier. • Measure voltage at pin 9 (BRAKE GR/BK) while pressing either the brake or clutch pedal.	APPROXIMATELY FIVE VOLTS	AMPLIFIER IS PROVIDING BRAKE/CLUTCH OVERRIDE SIGNAL. Proceed to next test.
	FIVE VOLTS NOT MEASURED	AMPLIFIER IS NOT PROVIDING BRAKE/CLUTCH OVERRIDE SIGNAL. Replace amplifier.



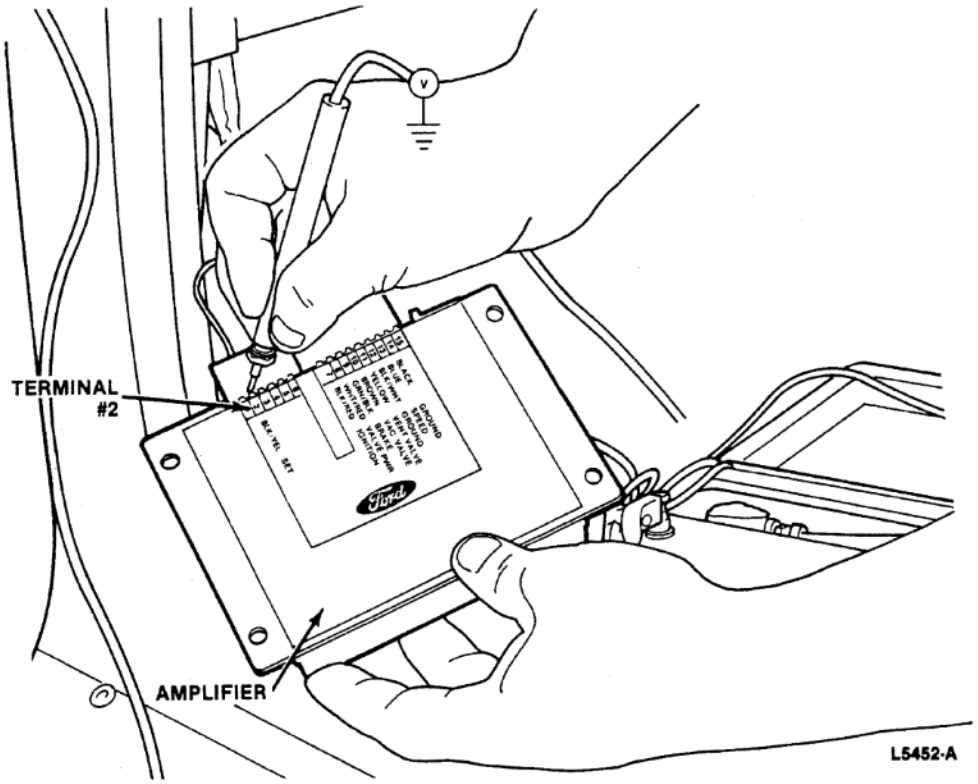
CL5417-A22

DIAGNOSTIC CHART (Continued)

SPEED CONTROL DIAGNOSTIC CHART (Continued)

27 SET/DECEL SIGNAL FROM SET SWITCH

TEST STEP	RESULTS	ACTION TO TAKE
• While holding the set switch in, measure voltage at amplifier pin 2 (SET BK/YL).	BATTERY VOLTAGE	AMPLIFIER IS RECEIVING SET/DECEL SIGNAL. Proceed to next test.
	NO BATTERY VOLTAGE	AMPLIFIER IS NOT RECEIVING SET/DECEL SIGNAL. Repair open in wire from set switch to amplifier.



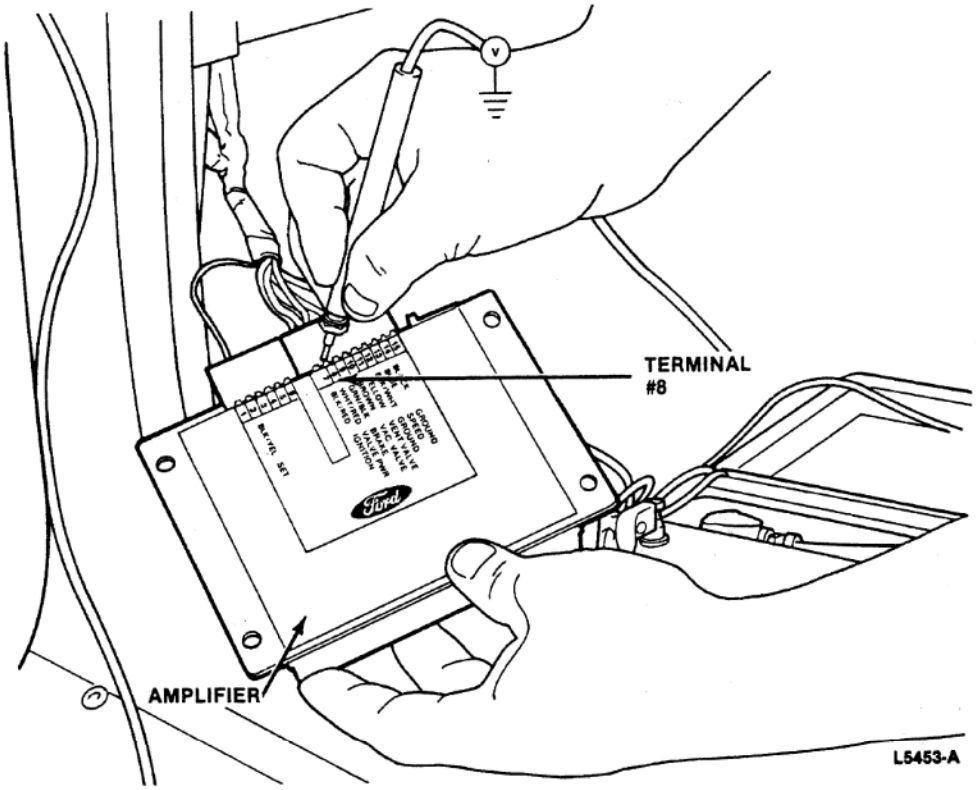
CL5417-A23

DIAGNOSTIC CHART (Continued)

SPEED CONTROL DIAGNOSTIC CHART (Continued)

26 POWER FEED FROM AMPLIFIER TO SERVO

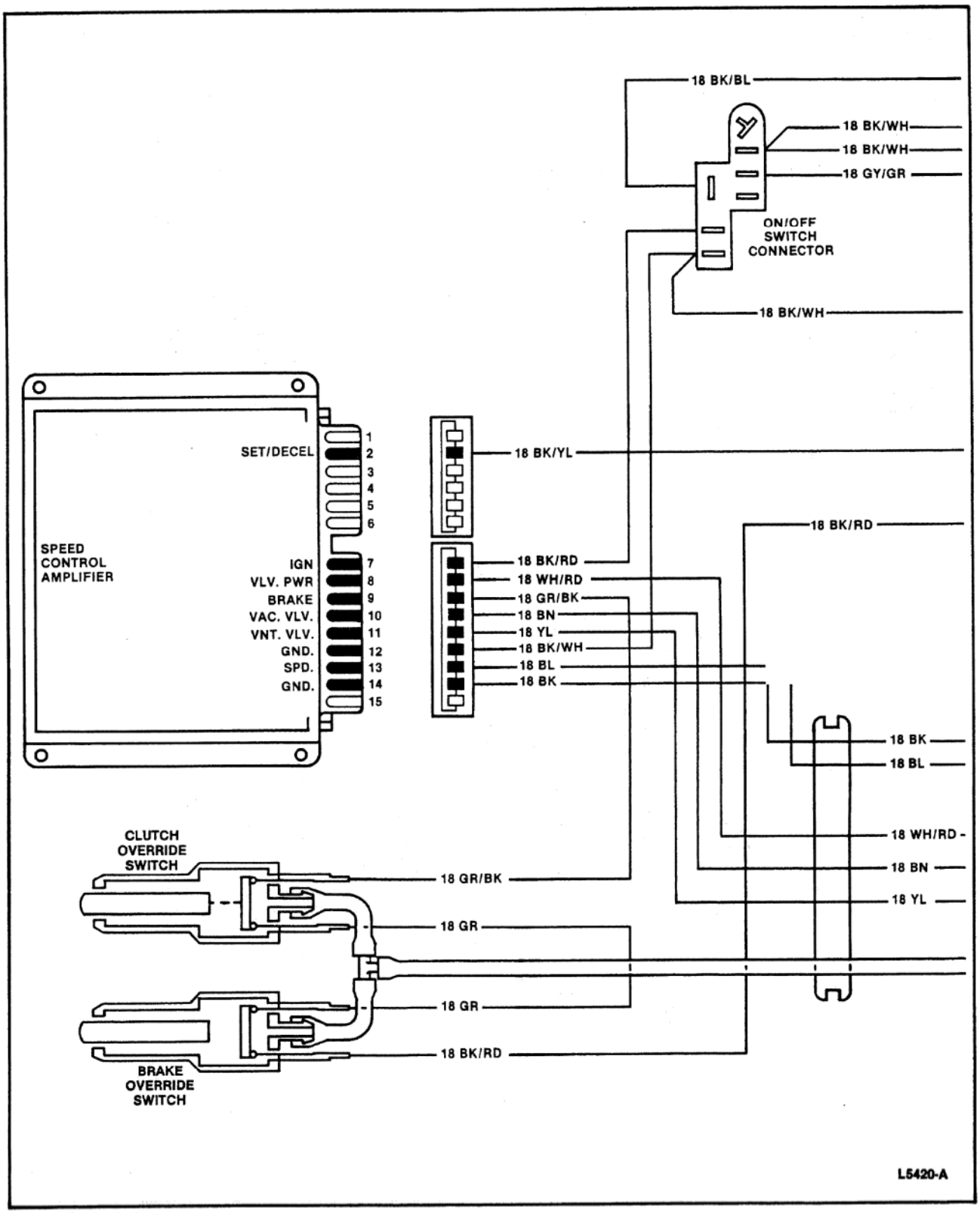
TEST STEP	RESULTS	ACTION TO TAKE
• Remove amplifier attaching screws and lower into an accessible position. Do not disconnect amplifier wiring. (Amplifier removal procedure is included in Section 37-06.) • Using a voltmeter, measure voltage at amplifier pin 8 (VALVE PWR WH/RD).	BATTERY VOLTAGE	AMPLIFIER IS SUPPLYING SERVO POWER FEED. Repair open in wire from amplifier to servo.
	NO BATTERY VOLTAGE	AMPLIFIER IS NOT SUPPLYING POWER FEED. Check for voltage at amplifer pin 7 (BK/RD). — If voltage is present, replace amplifier. — If voltage is not present, go to test 16.



CL5417-A24

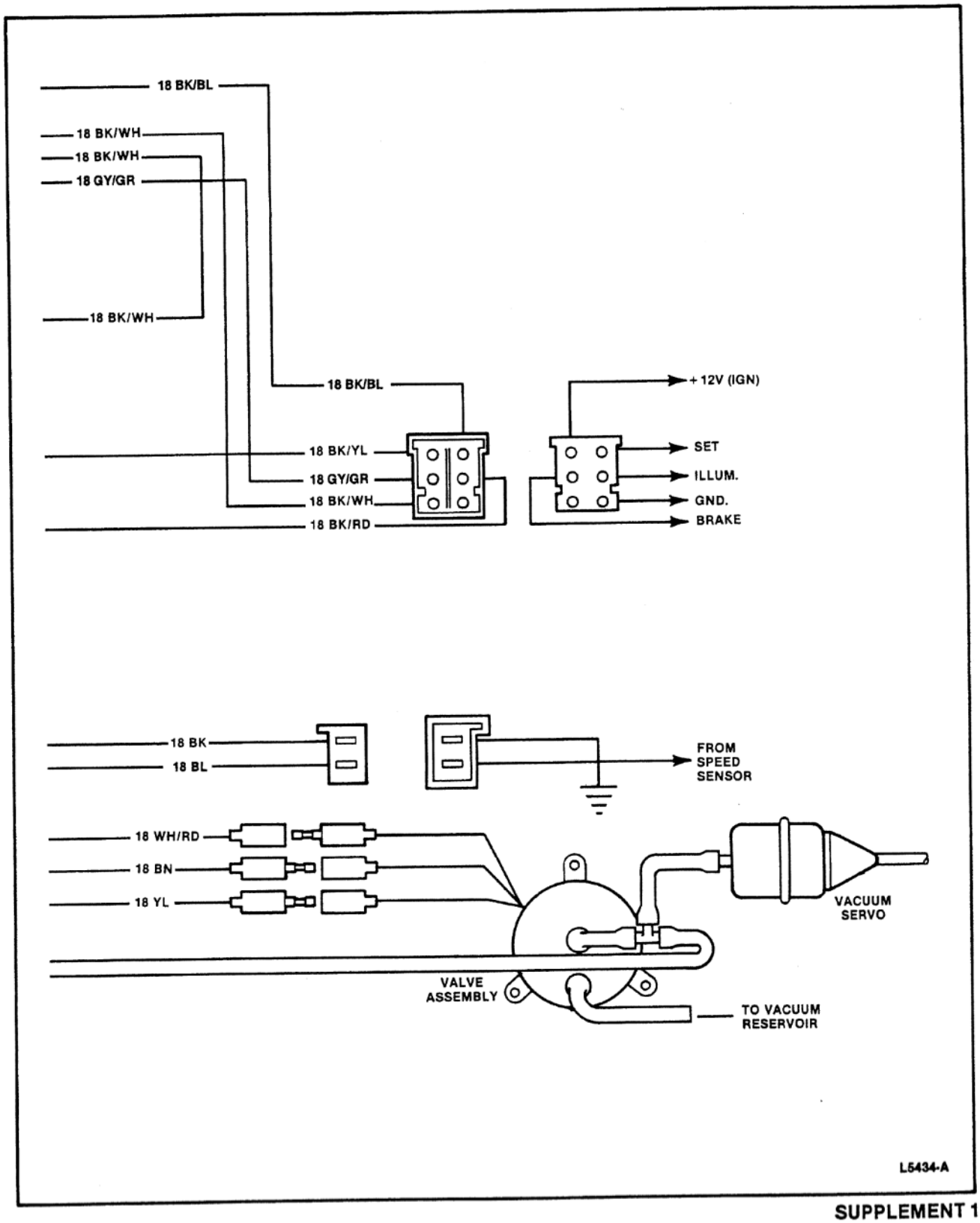
SUPPLEMENT 1

ELECTRICAL SCHEMATIC



SUPPLEMENT 1

ELECTRICAL SCHEMATIC (Continued)



SUPPLEMENT 1

SECTION 37-06 SPEED CONTROL

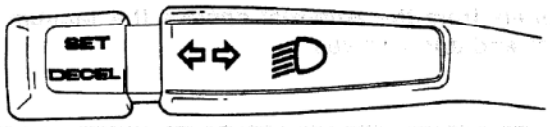
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DESCRIPTION 1

REMOVAL AND INSTALLATION

- ON/OFF Switch 2
- Speed Sensor 2
- Set/Decel Switch 3
- Vacuum Valve Assembly 3
- Clutch/Brake Override Switches 4
- Amplifier 5
- Servo Cable 6
- Vacuum Servo 7



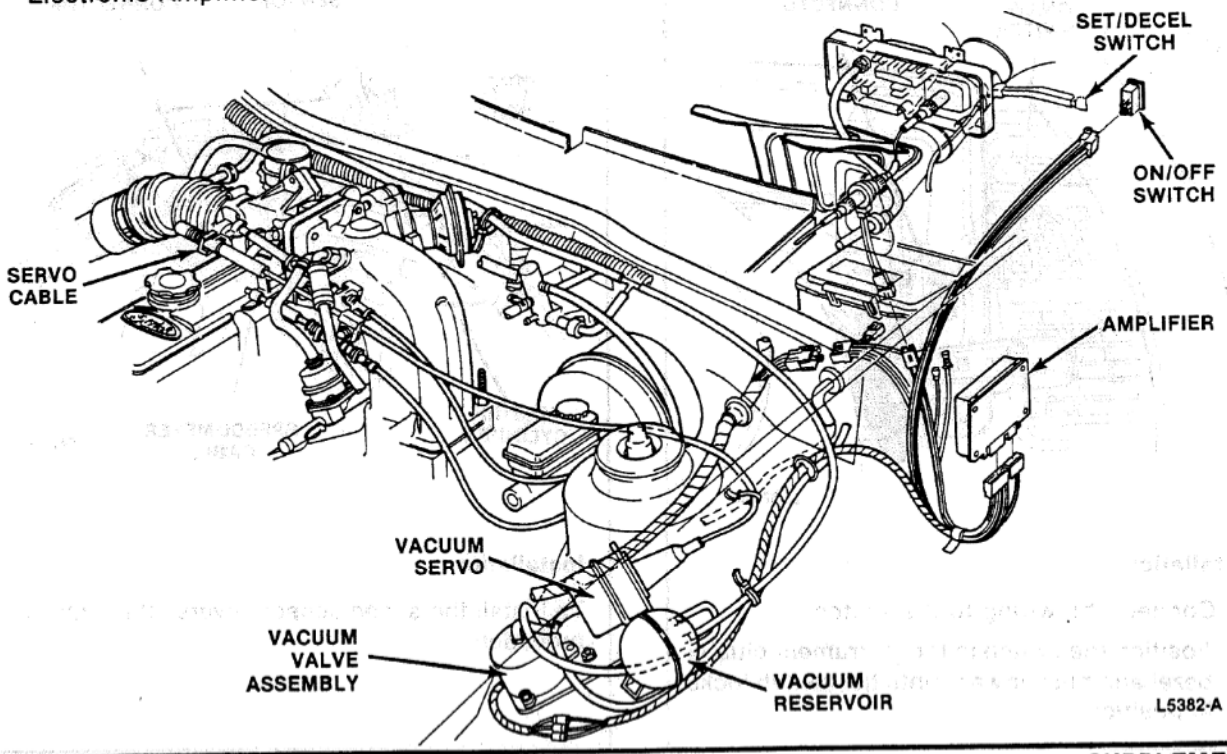
L5383-A

DESCRIPTION

The speed control system consists of the following components:

- ON/OFF Switch
- Set/Decel Switch
- Electronic Amplifier
- Speed Sensor
- Servo Assembly

The rocker-type ON/OFF switch is located on the left side of the instrument panel above the heater/AC side panel register.



L5382-A

DESCRIPTION (Continued)

The set/decel push button switch is mounted on the end of the turn signal switch stalk.

The electronic amplifier is mounted on the left cowl panel under the instrument panel. The amplifier receives inputs from the speed sensor, set switch, ON/OFF switch, brake override switch and, if equipped with a manual transmission, the clutch override switch. Output signals from the amplifier operate the vacuum vent and apply valves.

The speed sensor is located in the engine compartment near the brake master cylinder. The sensor is connected between the two speedometer cables and generates and AC voltage that provides a vehicle speed signal to the amplifier.

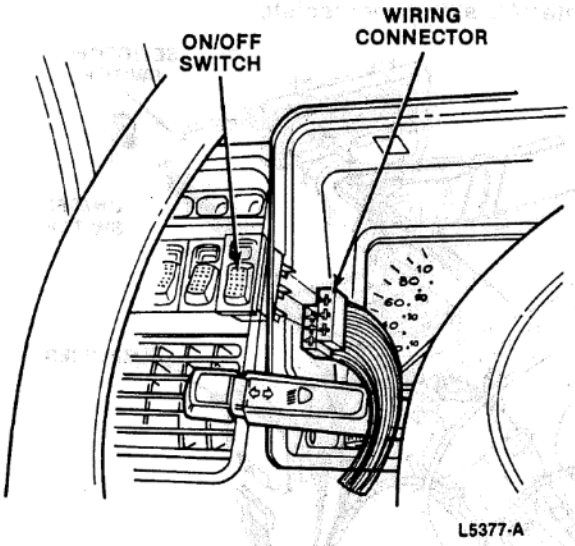
The vacuum servo assembly is mounted in the engine compartment on the left fender apron. Using engine vacuum, the servo is able to position and hold the throttle at a specific speed. Application and venting of vacuum from the servo is controlled by the electronic amplifier.

REMOVAL AND INSTALLATION

ON/OFF SWITCH

Removal

1. Using a thin bladed screwdriver, carefully pry the switch out of the instrument panel bezel.
2. Disconnect the wiring from the switch and remove the switch.



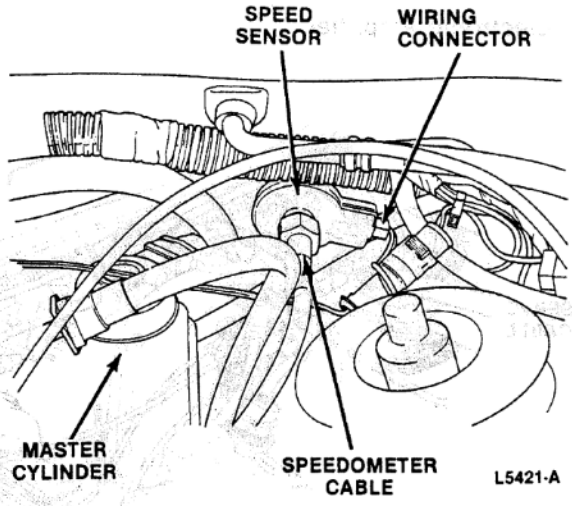
Installation

1. Connect the wiring to the switch.
2. Position the switch in the instrument cluster bezel and push inward until the switch locks in position.

SPEED SENSOR

Removal

1. Disconnect the speedometer cables.
2. Remove the speed sensor attaching nut.
3. Disconnect the wiring and remove the sensor.



Installation

To install the speed sensor, reverse the removal procedure.

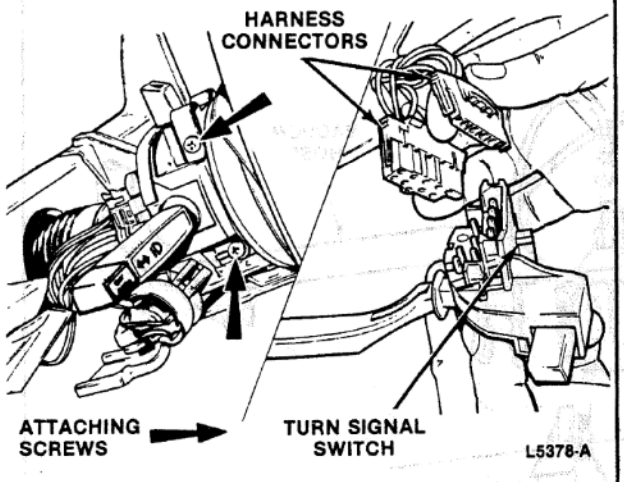
REMOVAL AND INSTALLATION (Continued)

SET/DECEL SWITCH

NOTE: The set/decel switch is integral with the turn signal switch and must be replaced only as a complete assembly.

Removal

1. Disconnect the battery negative cable.
2. Remove the steering column upper trim cover.
3. Remove the steering column lower trim cover.
4. Remove the turn signal switch attaching screws.
5. Disconnect the turn signal switch wiring and remove the switch.



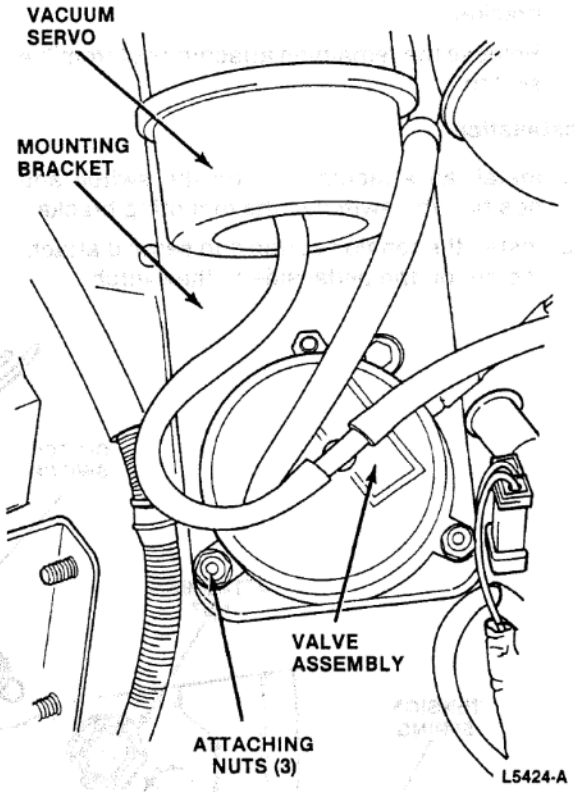
Installation

1. Position the turn signal switch on the steering column and install the attaching screws.
2. Connect the wiring to the turn signal switch.
3. Install the steering column trim covers.
4. Connect the battery negative cable.

VACUUM VALVE ASSEMBLY

Removal

1. Disconnect the vacuum hoses from the valve.
2. Separate the wiring connectors.
3. Remove the valve attaching nuts and the valve assembly.



Installation

1. Position the valve assembly on the mounting bracket and install the attaching nuts.
2. Connect the wiring.
3. Connect the vacuum hoses.

REMOVAL AND INSTALLATION (Continued)

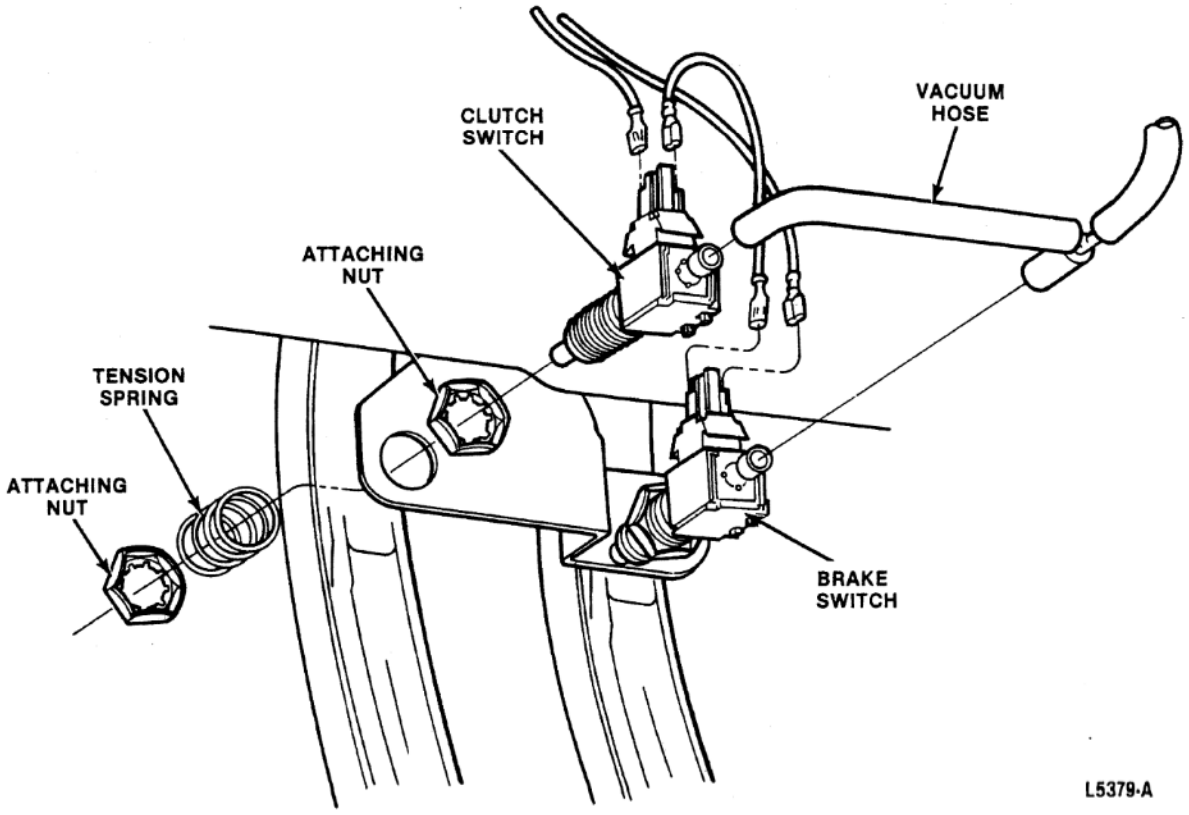
CLUTCH/BRAKE OVERRIDE SWITCHES

Removal

1. Remove the sound deadening panel located under the instrument panel.
2. Disconnect the vacuum hose from the switch.
3. Disconnect the wiring from the switch.
4. Remove the attaching nut and tension spring from the pedal side of the switch.
5. Remove the switch from the mounting bracket.
6. Remove the remaining attaching nut from the switch.

Installation

1. Install an attaching nut on the switch and position the switch in the mounting bracket.
2. Install the tension spring and second attaching nut on the pedal side of the switch.
3. To adjust the switch, proceed as follows:
   - — Connect the leads from an ohmmeter to the switch electrical terminals.
   - — Turn the attaching nuts until the switch opens and the ohmmeter no longer indicates continuity.
   - — Carefully rotate the attaching nuts in the opposite direction to the point where the ohmmeter again reads continuity.
4. Tighten the attaching nut on switch side of the mounting bracket.
5. Connect the wiring to the switch.
6. Connect the vacuum hose to the switch.
7. Install the sound deadening panel under the instrument panel.

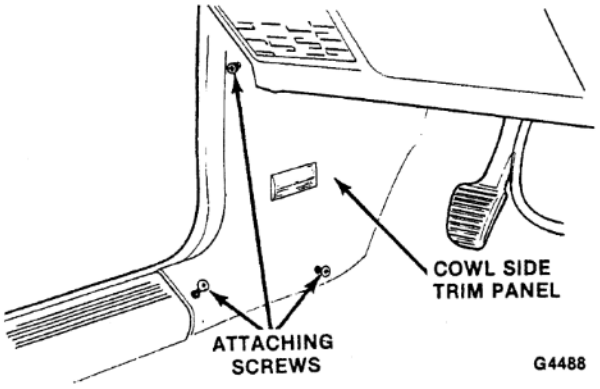


REMOVAL AND INSTALLATION (Continued)

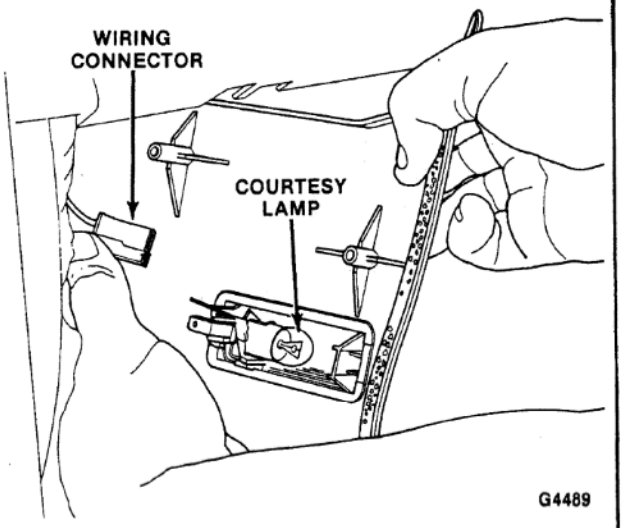
AMPLIFIER

Removal

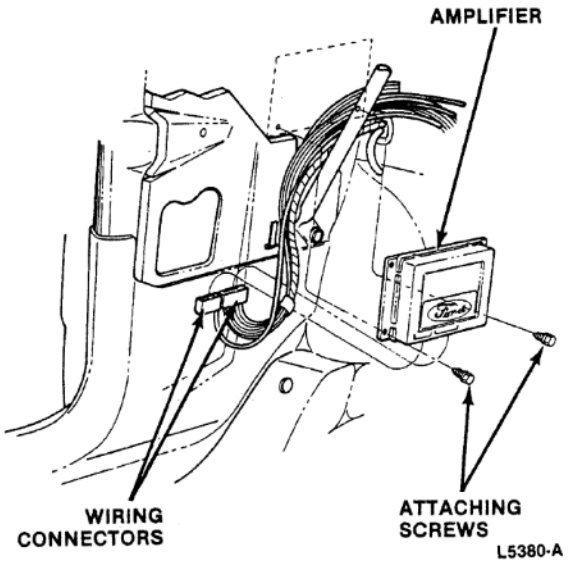
1. Remove the sound deadening panel located under the left side of the instrument panel.
2. Remove the cowl side trim panel attaching screws.



3. Pull the cowl side trim panel away from the body, disconnect the courtesy light wires and remove the panel.



4. Remove the amplifier attaching screws.
5. Disconnect the wiring from the amplifier.
6. Lower the amplifier downward and out from under the instrument panel.



Installation

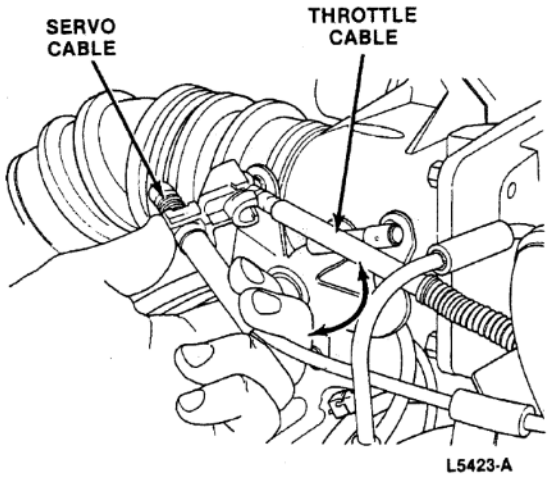
1. Position the amplifier under the instrument panel and install the attaching screws.
2. Connect the amplifier wiring.
3. Position the cowl side trim panel, connect the courtesy light wires and install the panel attaching screws.
4. Install the sound deadening panel under the instrument panel.

REMOVAL AND INSTALLATION (Continued)

SERVO CABLE

Removal

1. Remove the screw attaching the cable to the routing bracket located near the throttle body.
2. Remove the screw attaching the cable routing clip to the left strut tower.
3. Disconnect the cable from the throttle cable. To disengage the servo cable from the throttle cable, grip the servo cable and pivot it toward the front of the vehicle.
4. Remove the servo attaching nuts.
5. Remove the clip attaching the cable to the servo shaft and remove the cable.

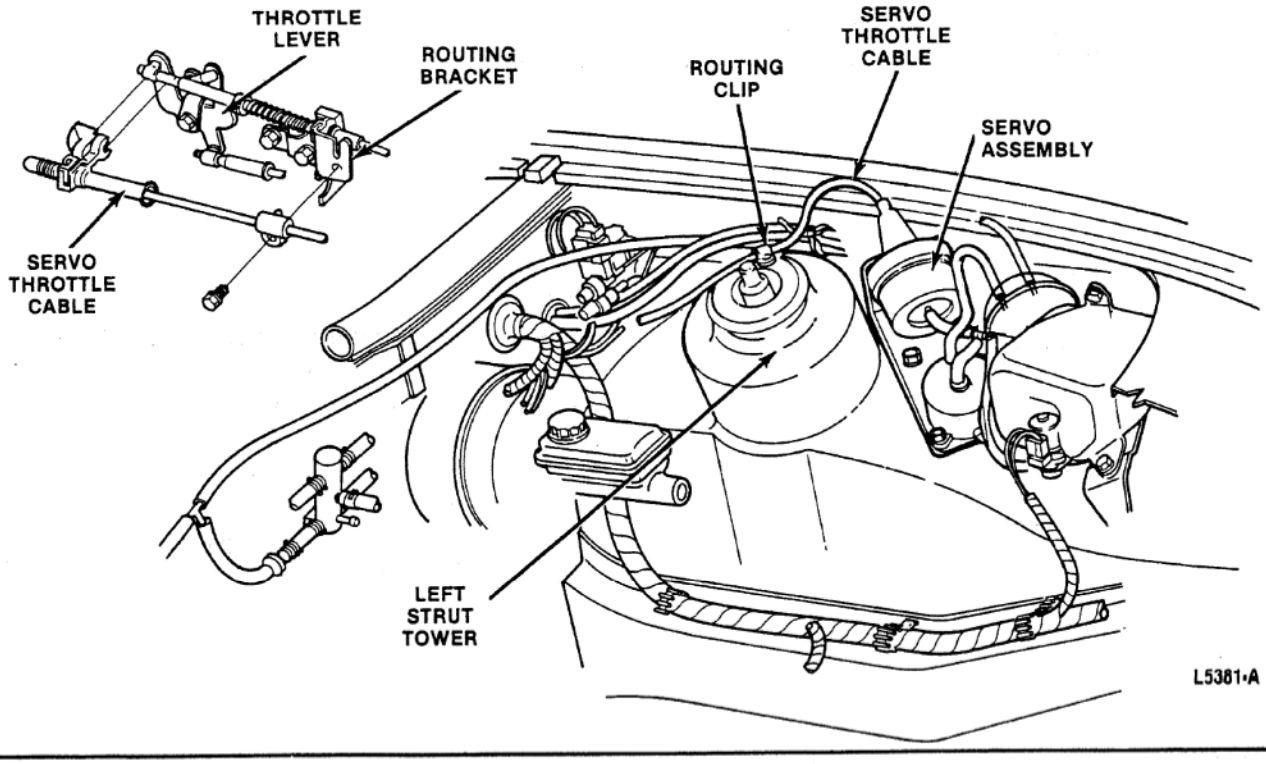


Installation

1. Position the servo cable over the servo shaft and install the retaining clip.

NOTE: The retaining clip is installed in the hole closest to the servo.

2. Position the servo in the mounting bracket and install the attaching nuts.
3. Connect the servo cable to the throttle cable.
4. Position the cable and install the screw attaching the cable to the routing bracket.
5. Position the cable and install the screw attaching the routing clip to the left strut tower.

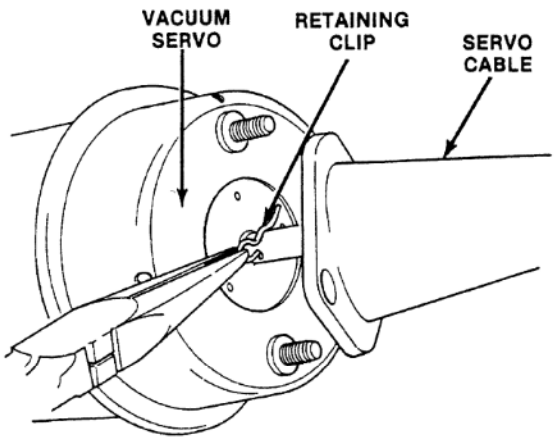


REMOVAL AND INSTALLATION (Continued)

VACUUM SERVO

Removal

1. Block the throttle in the wide open position by placing a socket between the throttle lever and the idle adjustment screw.
2. Remove the servo attaching nuts.
3. Remove the clip attaching the throttle cable to the servo shaft and remove the servo.

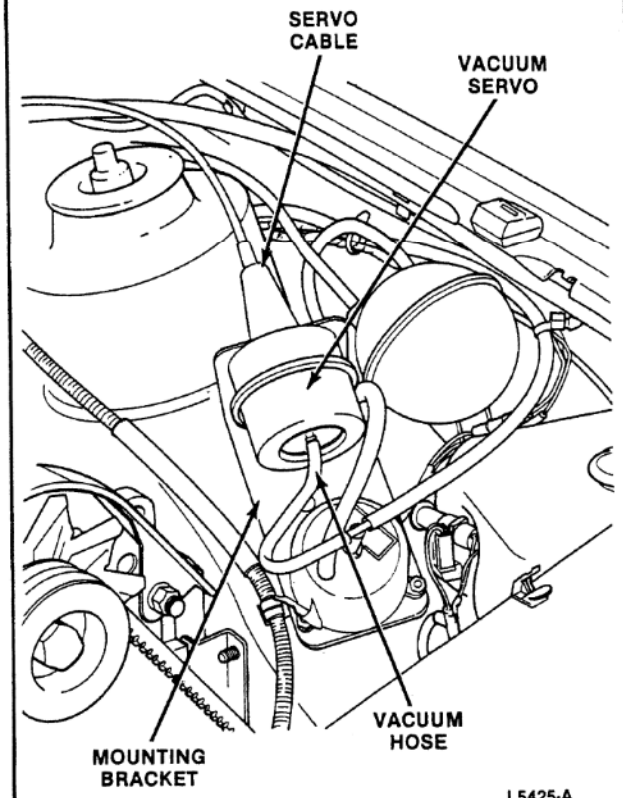


Installation

1. Position the throttle cable over the servo shaft and install the retaining clip.

NOTE: The retaining clip is installed in the hole closest to the servo.

2. Position the servo on the mounting bracket and install the attaching nuts.
3. Remove the socket holding the throttle open.



SEATS

GROUP 41 (60000)

TITLE SECTION — PAGE NO.

SEAT TRACKS—MANUAL 41-01

DESCRIPTION 1
REMOVAL AND INSTALLATION
- Seat Track 1
- Adjuster Assembly 3

CONVENTIONAL REAR SEAT 41-14

DESCRIPTION 1
REMOVAL AND INSTALLATION
- Cushion, Rear Seat 2
- Hinge, Rear Seat Backrest 2
- Catch, Rear Seat 3

SEAT BACK LATCH—MANUAL 41-25

DESCRIPTION
- Reclining Mechanism 2

REMOVAL AND INSTALLATION
- Reclining Mechanism 2
- Tilt Lock Lever Knob 3
- Seat Latch Release Lever 3
- Lumbar Support Handwheel/Cam 4

HEAD RESTRAINTS 41-40

DESCRIPTION 1
REMOVAL AND INSTALLATION 1

SEAT AND SHOULDER BELTS 41-50

DESCRIPTION 1

TESTING
- Continuous Loop Shoulder/ Lap Belt Test 1
- Testing the Webbing Sensor 1
- Testing the Vehicle Sensor 2

REMOVAL AND INSTALLATION
- Front Seat Belt Retractor and Belt 2
- Front Seat Belt Buckle 4
- Rear Seat Belt Retractor and Belt 5
- Rear Center Buckle and Lap Belt 6

SEAT TRIM AND HEATED SEAT 41-60

DESCRIPTION
- Heated Seat Pad 1

REMOVAL AND INSTALLATION
- Back Cover, Front Seat 2
- Cushion Cover, Front Seat 4
- Cushion Cover, Rear Seat 4
- Back Cover, Rear Seat 5
- Heated Seat Cushion 6

SECTION 41-01 SEAT TRACKS—MANUAL

CONTENTS

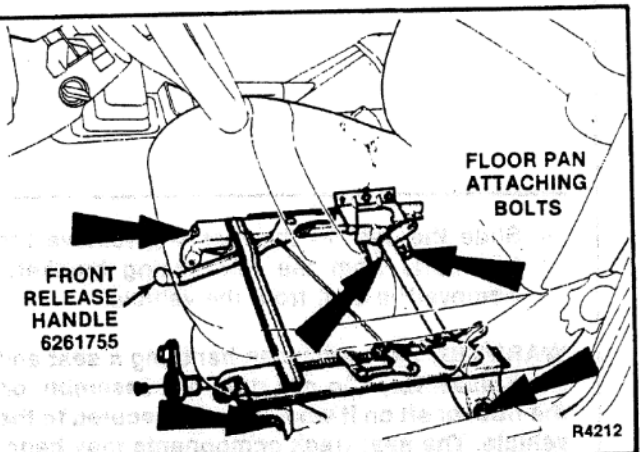
Page

DESCRIPTION 1

REMOVAL AND INSTALLATION
- Seat Track 1
- Adjuster Assembly 3

DESCRIPTION

Manual seat tracks are attached to the floor pan by five bolts. The seat release handle is located at the front of the seat. Tripping the seat release handle will allow forward or rearward movement of the seat.

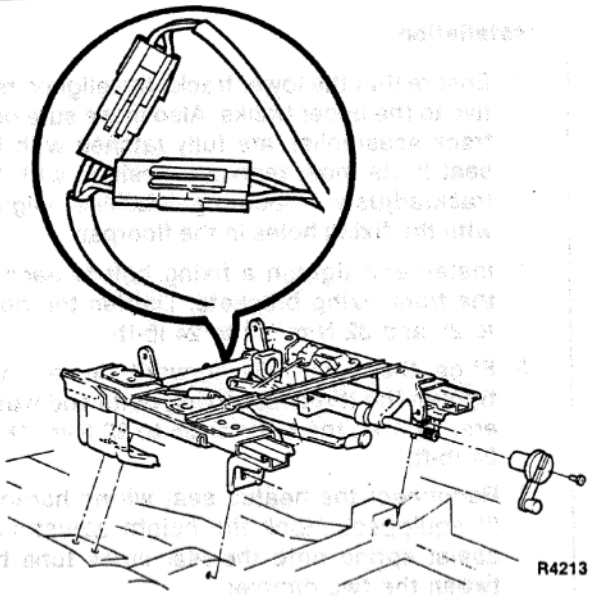


REMOVAL AND INSTALLATION

SEAT TRACK

Removal

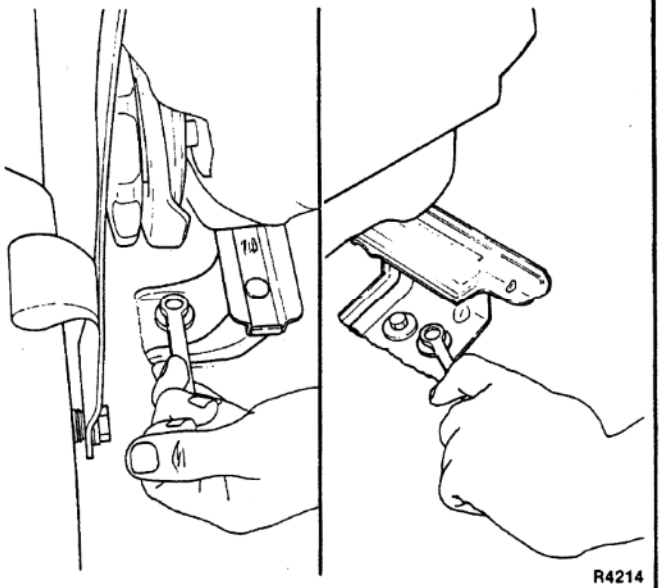
1. Slide the seat as far forward as possible. Disconnect the heated seat wiring harness (if equipped).
2. Unhook the adjuster assist spring from the rear cross tube.



REMOVAL AND INSTALLATION (Continued)

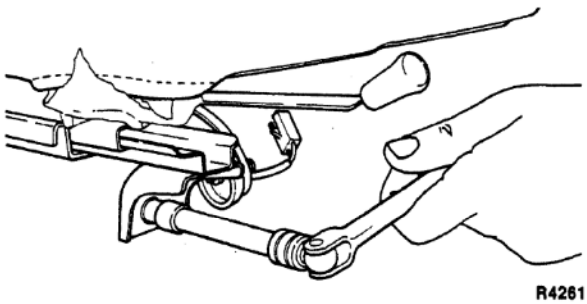
SEAT TRACK REMOVAL (Continued)

3. Remove the two bolts from the inner fixing bracket and one bolt from the outer fixing bracket securing the rear of the seat.


R4214

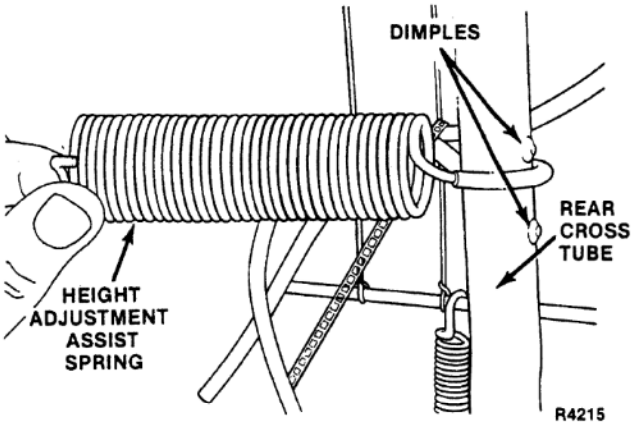
4. Slide the seat to the rear and remove the two bolts from the front fixing brackets. Remove the seat from the vehicle.

WARNING: Use care when handling a seat and track assembly. Do not drop the assembly on the floor or sit on it when it is not secured to the vehicle. The seat track components may bend, resulting in an inoperative seat track.


R4261

Installation

1. Ensure that the lower tracks are aligned relative to the upper tracks. Also make sure both track assemblies are fully latched with the seat in its most rearward position with the track/adjuster mounting brackets aligned with the fixing holes in the floorpan.
2. Install and tighten a fixing bolt to each of the front fixing brackets. Tighten the bolts to 25 and 32 N·m (18 to 24 lb-ft).
3. Slide the seat fully forward. Install and tighten the three rear fixing bolts and washers. Tighten the bolts to 25 to 32 N·m (18 to 24 lb-ft).
4. Reconnect the heated seat wiring harness (if equipped). Hook the height adjustment assist spring onto the rear cross tube between the two dimples.



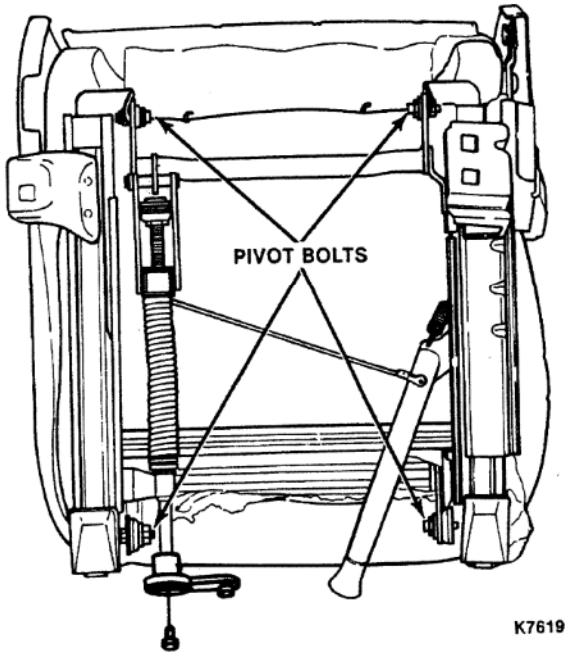
R4215

REMOVAL AND INSTALLATION (Continued)

ADJUSTER ASSEMBLY

Removal

1. After removing the seat, invert it. Remove the four pivot bolts securing the seat adjuster to seat frame and remove the adjuster assembly.



Installation

1. Align the adjuster pivot brackets with the retaining brackets on the seat cushion frame.
2. Install the four retaining pivot bolts.Tighten the bolts to 25 to 32 N·m (18 to 24 lb-ft).

SECTION 41-14 CONVENTIONAL REAR SEAT

CONTENTS

Page

DESCRIPTION 1

REMOVAL AND INSTALLATION

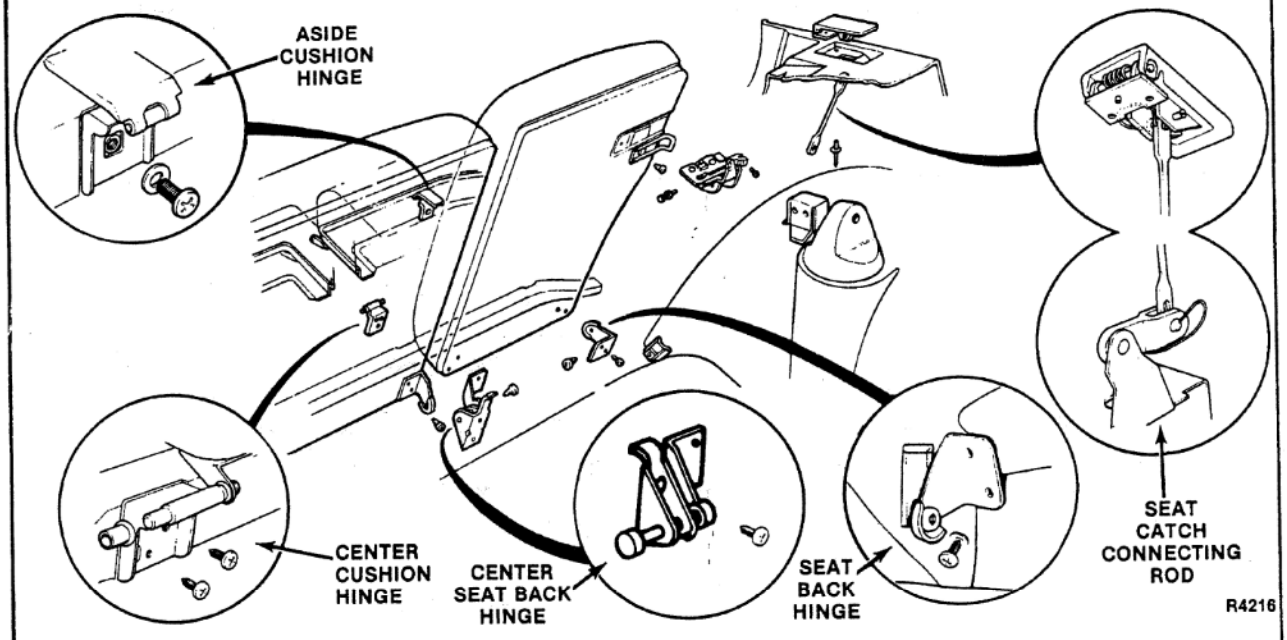
Cushion, Rear Seat 2
Hinge, Rear Seat Backrest 2
Catch, Rear Seat 3

DESCRIPTION

The rear seat cushion and seat back assembly is an asymmetrically split seat. The two rear seat cushions fold forward either jointly or individually and the rear seat backs fold down to provide additional load compartment space.

To convert either or both seat sections for additional load compartment storage, pull the seat cushion(s) fully up. Then, release the seat back latch located in the rear parcel shelf. The seat back(s) can then be folded flat.

REAR SEAT ASSEMBLY

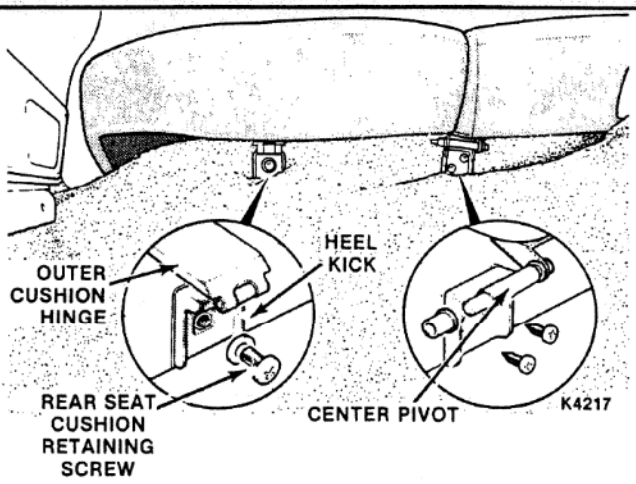


REMOVAL AND INSTALLATION

CUSHION, REAR SEAT

Removal

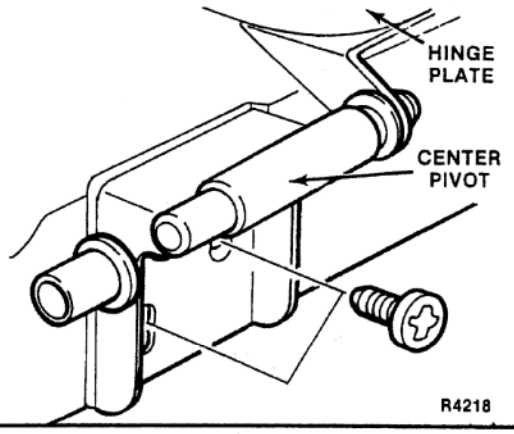
1. Remove the two rear seat cushion retaining screws, one on each side, that hold the outer cushion hinges to the heel kick.
2. Slide the cushion(s) sideways off the center pivot.
3. Lift the rear seat cushions out of the vehicle.



Installation

1. Position the seat cushions in the vehicle.
2. Slide the cushion onto the center pivot. Align the outer seat cushion hinges with their locating holes in the heel plate.
3. Install a retaining screw into each of the outer cushion hinges.

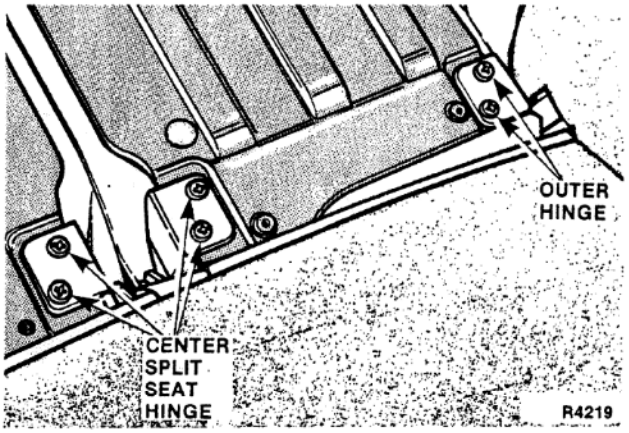
NOTE: The center pivot may be removed/installed by removing/installing the two fixing screws.



HINGE, REAR SEAT BACKREST

Removal

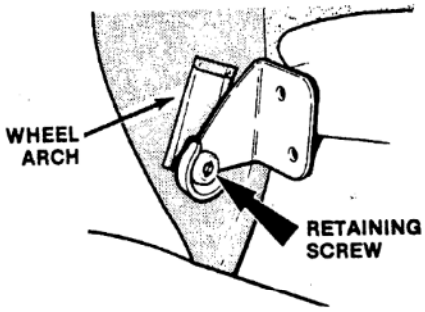
1. Fold down the rear seat backrest assembly.
2. Remove trim panel from rear of rear seat backrest. Fold down the rear seat backrest as described in the description above.
3. Remove the two screws, one on each side, securing the outer hinges. Remove the four screws holding the center split seat hinge.



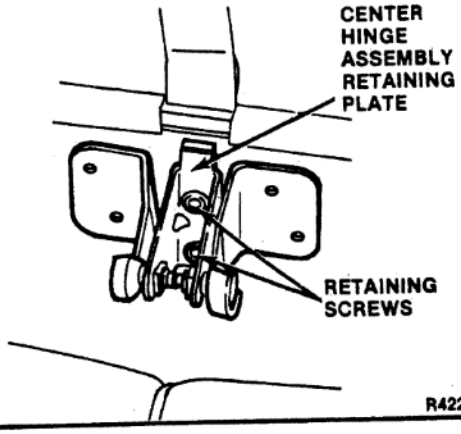
REMOVAL AND INSTALLATION (Continued)

HINGE, REAR SEAT BACKREST (Continued)

4. Remove both seat backrests from the vehicle.
5. Remove the one bolt on each side holding the hinge assembly to the wheel arch. Detach the hinges.



6. Remove the two screws holding the center hinge assembly retaining plate. Remove the hinge.



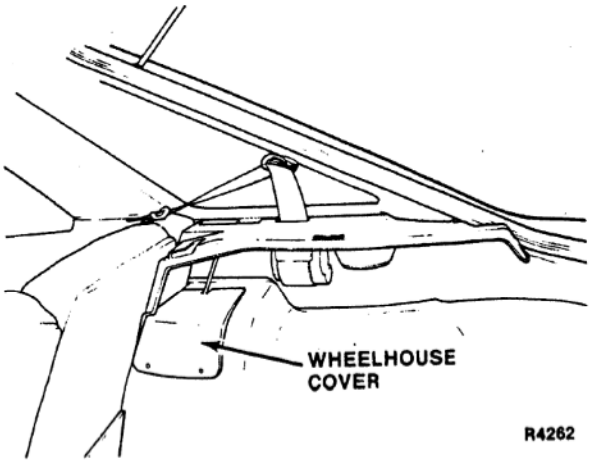
Installation

1. Position the wheel arch hinge assemblies on each side and install one bolt to retain the assemblies.
2. Position the center hinge assembly with two screws.
3. Position the fixing holes in the backrest assembly to the center and outer hinge assemblies. Install the retaining screws.
4. Fold up the rear seat backrest assembly.

REAR SEAT CATCH

Removal

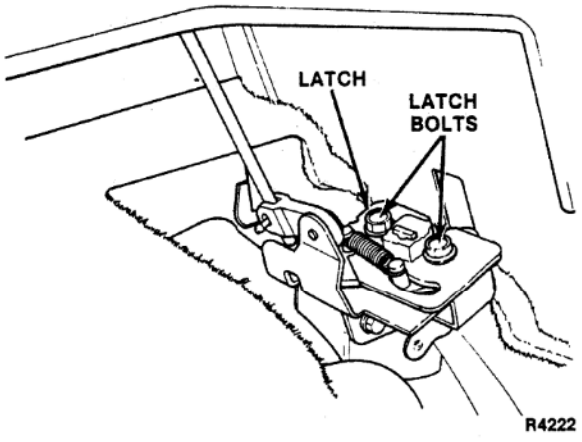
1. Fold down the rear seat backrest assembly.
2. Remove the wheel house cover.



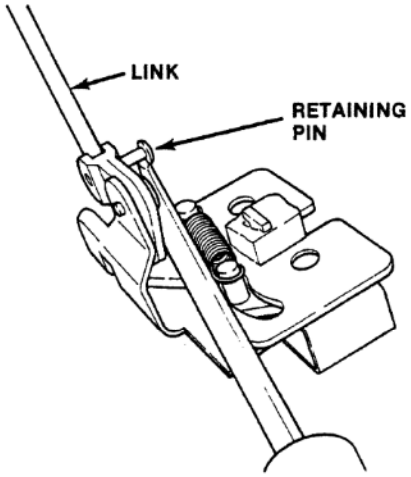
REMOVAL AND INSTALLATION (Continued)

REAR SEAT CATCH (Continued)

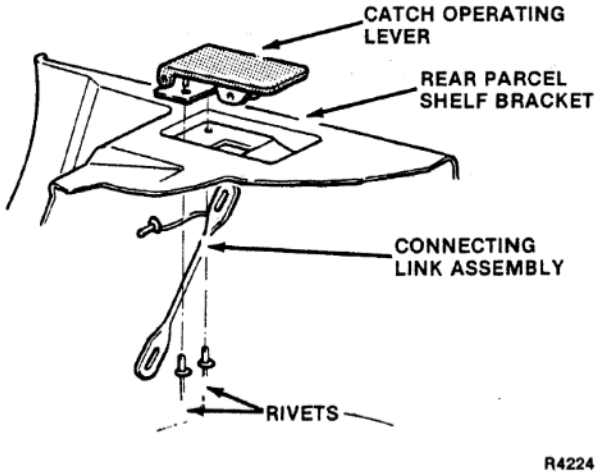
3. Remove the two bolts holding the latch to the wheel house.



4. Disconnect the link from the latch mechanism by pushing out the retaining pin. Remove the latch mechanism.



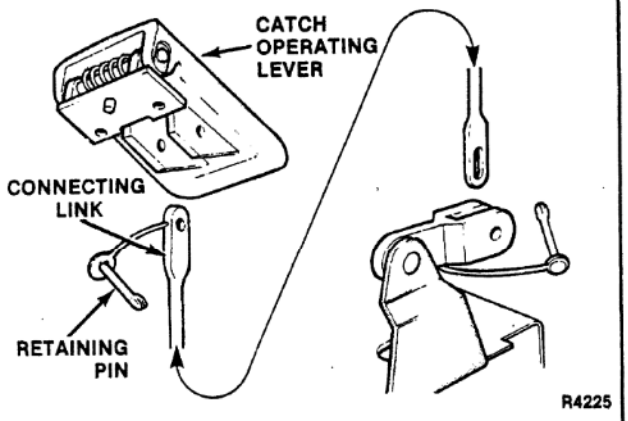
5. If necessary, drill out the two rivets holding the catch operating lever to the rear parcel shelf bracket and connecting link assembly. Disconnect the link by pushing out the retaining pin.



REMOVAL AND INSTALLATION (Continued)

Installation

1. If applicable, fit a new link to the lever using the integral pin. Position the lever assembly into the rear parcel shelf bracket and re-attach with two rivets.
2. Reattach the connecting link to the latch assembly with the retaining pin. If the pin was broken during removal, replace with a 4 mm nut and bolt.
3. Reconnect the latch mechanism to the wheel house using two bolts. Install wheel house cover.
4. Fold up the rear seat backrest assembly. Check the catch operation.



SECTION 41-25 Seat Back Latch—Manual

SUBJECT	PAGE
DESCRIPTION	
Reclining Mechanism	41-25-1
REMOVAL AND INSTALLATION	
Lumbar Support Handwheel/Cam	41-25-3
REMOVAL AND INSTALLATION (Cont'd.)	
Reclining Mechanism	41-25-1
Seat Latch Release Lever	41-25-2
Tilt Lock Lever Knob	41-25-2

DESCRIPTION

Reclining Mechanism

The reclining mechanism is operated by a handwheel that will recline the seat back at any position from the normal upright to fully lowered against the rear seat cushion as required.

Tilting the seat back to gain access to the rear passenger compartment is achieved by operating the lever on the entrance side of the seat.

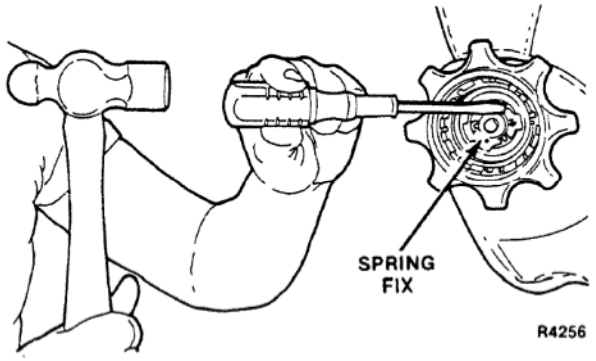
This lever operates a latch at the base of the seat back via a wire and spring mechanism. The front seat back latch cannot be removed. However, the seat back latch lever spring can be replaced by removing the lever and bezel.

The recliner mechanism is welded to the base of the front seat back frame. Removal of the reclining mechanism requires removal of the front seat back frame.

REMOVAL AND INSTALLATION

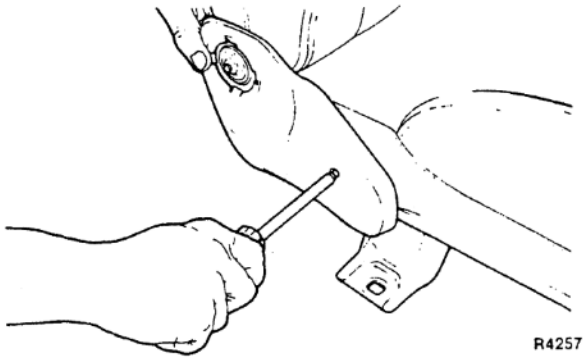
Reclining Mechanism

1. Remove front seat assembly from vehicle and place on a clean workbench. See Section 41-01 for details.
2. Using a thin-bladed screwdriver, pry the cap off the handwheel. Remove spring fix of handwheel and then remove handwheel.
3. Disengage spring fix lugs by rotating with a hammer and screwdriver.
4. Remove handwheel.

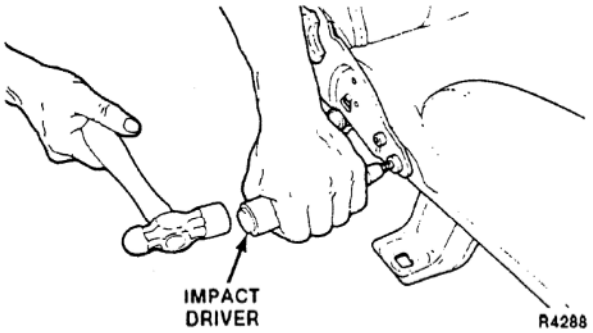


R4256

5. Remove screw retaining front seat pivot cover and remove front seat pivot cover.


R4257

6. Remove screws fixing mechanism cover on inner side of seat.
7. Remove forward pivot fixing bolt. Disengage seat back and reclining mechanism from cushion.
8. To install, reverse Steps 1 through 7.



R4288

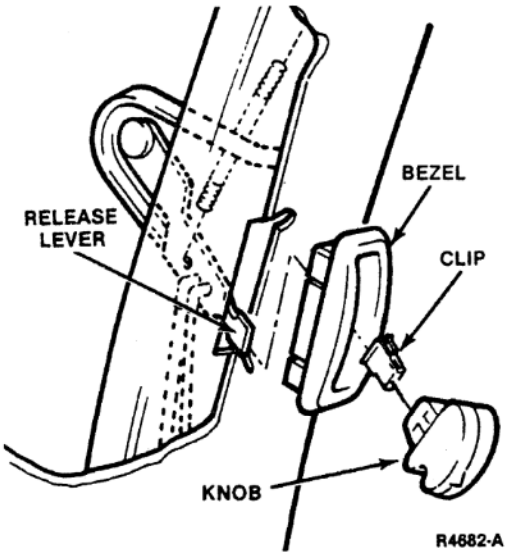
REMOVAL AND INSTALLATION (Continued)

Tilt Lock Lever Knob

NOTE: Removal of the tilt lever knob may result in damage to the knob retaining clip. Availability of a replacement clip should be checked before removing the knob.

To remove the knob, carefully pry it from the lever using a suitable screwdriver. Proper padding should be used between the screwdriver, knob and bezel to prevent damage to the plastic.

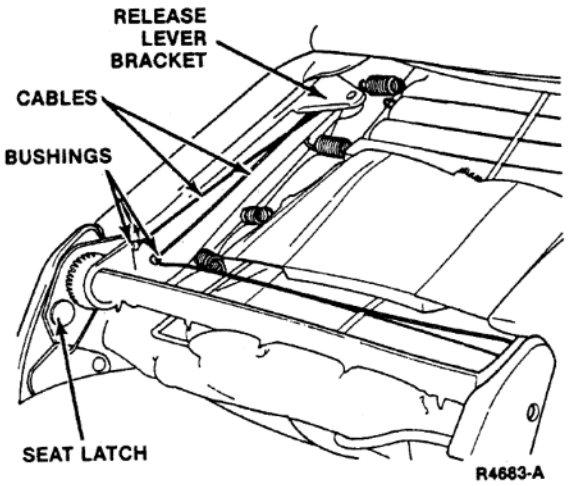
To install the knob using a new retaining clip, position the clip on the lever and then push the knob over the lever and clip until it locks in position. If the original clip is being used, push the knob and clip onto the lever as an assembly. If the knob does not lock firmly in place, remove it from the lever and install a new retaining clip.



Seat Latch Release Lever

The seat latch lever is riveted to a bracket welded to the seat frame. From the lever, two metal cables are routed to the release latches located at the bottom of the seat frame. The cables are attached to the lever and latches with "Z" type links.

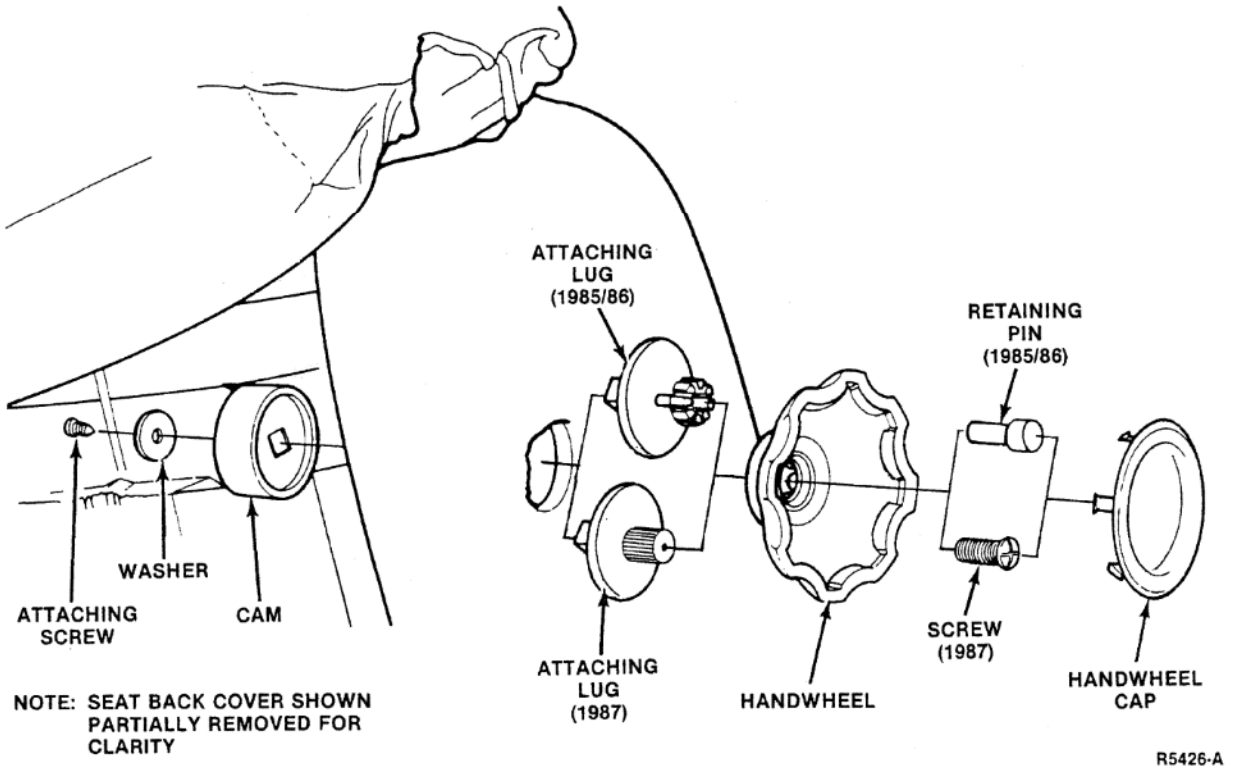
When the release lever is lifted, the cables disengage the seat latches from the locking pins allowing the seat to be tilted forward. To prevent contact between the cables and seat frame, nylon bushing are installed at cable routing points.



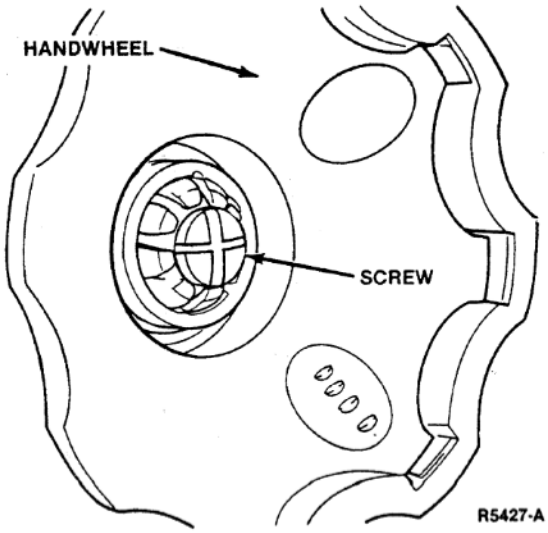
REMOVAL AND INSTALLATION (Continued)

Lumbar Support Handwheel/Cam

Removal

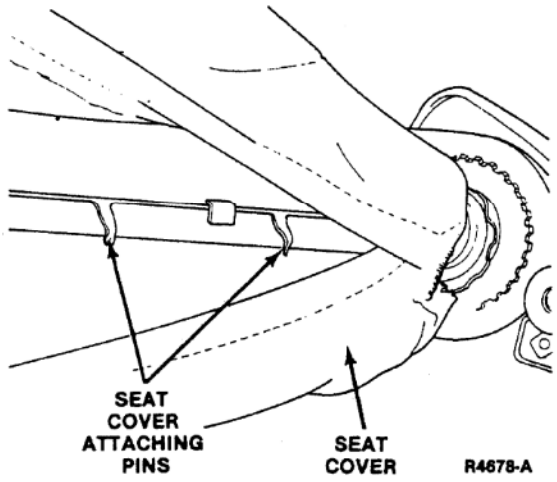


1. Using a small screwdriver, remove the handwheel cap.
2. Remove handwheel retaining screw and handwheel.

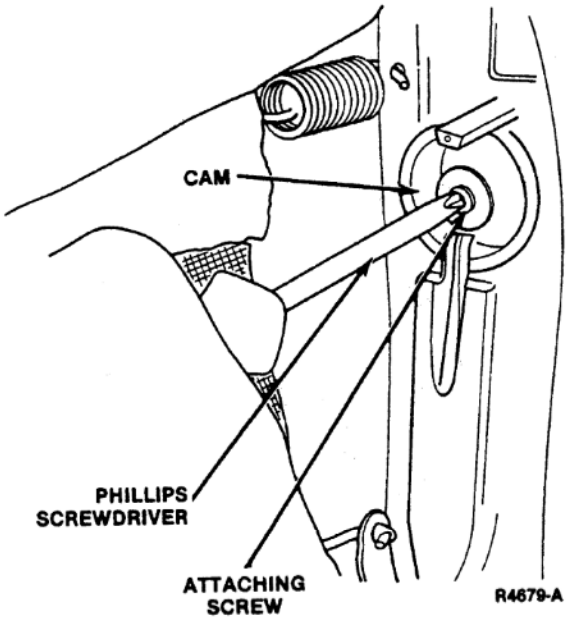


REMOVAL AND INSTALLATION (Continued)

3. Fold the seat back forward.
4. Straighten the seat back cover attaching pins and stretch the fabric off the pins.



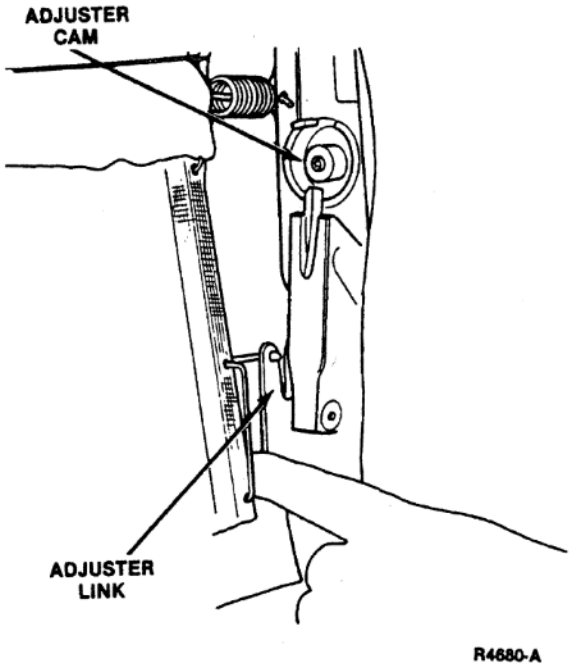
5. Reach up through the back of the seat cover and remove the phillips head screw attaching the adjuster cam to the handwheel lug.
6. Remove the attaching screw washer and adjuster cam from the seat back.



Installation

1. If a new handwheel attaching lug is being installed, cut threads in the lug with the cam attaching screw before installing in the seat.
2. Position the adjuster cam in the seat under the adjuster lever.

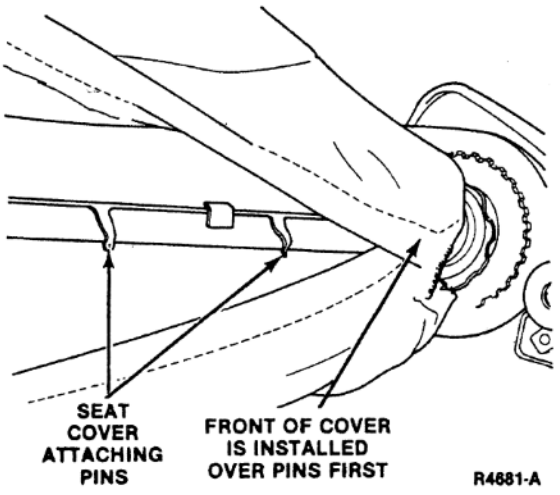
   If the cam does not seem to fit under the lever, press on the bottom of the adjuster link to gain additional clearance.



REMOVAL AND INSTALLATION (Continued)

3. Position the handwheel attaching lug through the adjuster cam and install the attaching screw and washer.
4. Stretch the seat back cover and link the fabric over the attaching pins.

   Note that the front of the seat cover is installed over the pins first. Also, be sure the pins pass through the fabric behind the rod located at the bottom of the seat cover.
5. Install the handwheel on the attaching lug and retain with screw or retaining pin.
6. Install the handwheel cap.



SECTION 41-40 HEAD RESTRAINTS

CONTENTS

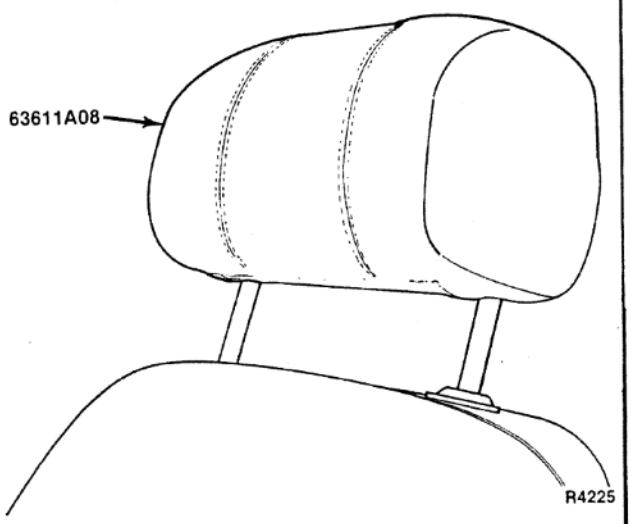
Page

DESCRIPTION 1

REMOVAL AND INSTALLATION 1

DESCRIPTION

The head restraints for the front seats have two stems that engage a spring-loaded catch in the mounting sleeve. The mounting sleeve assembly is mounted to a part of the seatback assembly. The new restraint can also be tilted fore and aft according to the driver and passenger comfort.

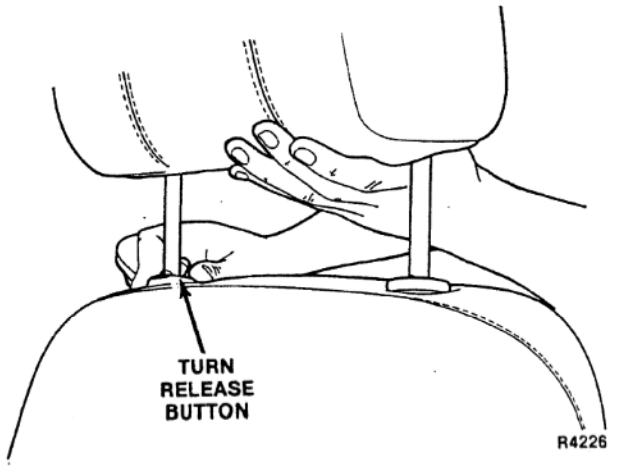


REMOVAL AND INSTALLATION

HEAD RESTRAINTS

Removal

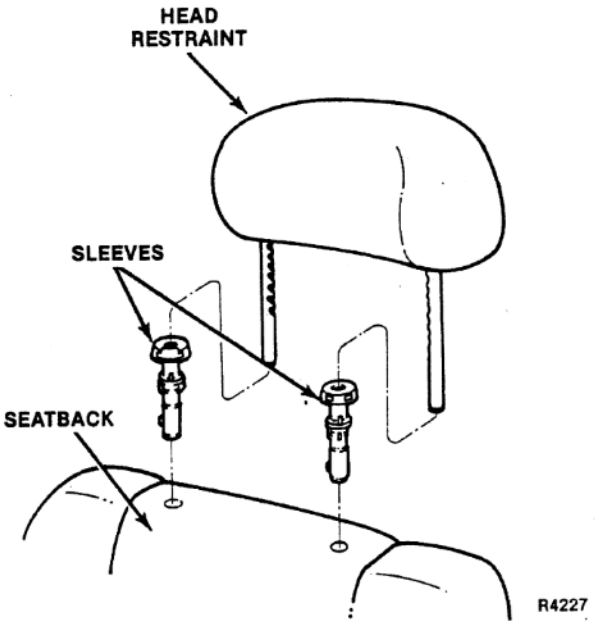
1. Remove headrest and headrest bezel. Raise head restraint to fully upward position. Depress the release button on the right-hand sleeve and simultaneously pull the head restraint up and out of the sleeves.



REMOVAL AND INSTALLATION (Continued)

HEAD RESTRAINTS (Continued)

2. Remove the sleeve by rotating 90 degrees counterclockwise (using slots in the top of sleeve) and then pulling the sleeve upward.



Installation

1. Insert the sleeve through the top of the seatback with the larger of the two attaching lugs facing the right side of the seat. Push the sleeves into the seat and rotate 90 degrees clockwise to lock in position.
2. Install the head restraint by inserting its two stems into the sleeves until the notches engage.

SECTION 41-50 SEAT AND SHOULDER BELTS

CONTENTS

Page

DESCRIPTION 1

TESTING

Continuous Loop Shoulder/Lap Belt Test 1
Testing the Webbing Sensor 1
Testing the Vehicle Sensor 2

REMOVAL AND INSTALLATION

Front Seat Belt Retractor and Belt 2
Front Seat Belt Buckle 4
Rear Seat Belt Retractor and Belt 5
Rear Center Double Buckle and Lap Belt 6

DESCRIPTION

The vehicle is provided with four continuous loop, single retractor restraint systems plus a single lap belt is provided for the use of the person sitting in the center rear seat. The seat belt assemblies are factory-installed in their proper location. If they are removed for any reason, it is critical that they be reinstalled using the procedures in this section. It is important that all anchor bolts be tightened to the correct torque specifications. If any of the seat belt assemblies have been subjected to loading by the occupants in an accident then the complete assemblies (retractor and buckle) must be replaced.

NOTE: When renewing a faulty seat belt damaged by other than occupant loading in an accident, only the faulty buckle retractor assembly need be replaced. It is not necessary to renew both the buckle and retractor.

WARNING: It is not possible to interchange parts between different models.

The system incorporates a buzzer and lamp warning. The seat belt lamp lights up for about eight seconds after the ignition switch is turned on regardless of seat belt usage. The seat belt warning buzzer will sound for approximately eight seconds unless the driver's belt is used.

TESTING

CONTINUOUS LOOP SHOULDER/LAP BELT TEST

NOTE: The vehicle is equipped with two front and two rear seat belt systems, which are dual sensitive (i.e., will lock when webbing is extracted quickly or when the vehicle is braking, cornering or accelerating heavily).

TESTING THE WEBBING SENSOR

To establish that the webbing sensor is working, the vehicle should be stationary and level. The webbing coming from the retractor must be grasped firmly and pulled out quickly. The retractor should lock up and prevent further webbing payout after a few inches of initial extraction.

TESTING (Continued)

TESTING THE VEHICLE SENSOR

1. Buckle up and drive the vehicle to a safe test area. If the front and rear passenger belts are to be tested, a passenger should be buckled into the belt that requires testing.

NOTE: The seat belt should not be fully extended to preclude possibility of a false feeling (full extension vs. lockup).

2. Accelerate to a speed of approximately 5 mph (8 km/h). The driver should inform the passenger that he is prepared to make a severe brake application. At this time, both driver and passenger should grasp their respective shoulder harnesses and prepare to lean forward slightly at the moment the brake application is made.
3. The driver will make a maximum brake application without tire skidding. (The maximum brake application should be on dry concrete or equivalent hard road surface.) The driver and passenger should lean slightly into the shoulder harness. At this point, the belts should lock up without webbing payout.
4. If there is a lockup of the shoulder strap, the seat belt assembly is functioning properly. Should either or both retractors fail to lock up at 5 mph (8 km/h), the test must be repeated at 15 mph (24 km/h).
5. If any of the front or rear shoulder belts do not lock up at 15 mph (24 km/h), the vehicle is to be returned for replacement of the malfunctioning belt and retractor assembly.

NOTE: If the retractor of a new seat belt assembly has been bolted into a damaged or distorted mounting area, the new retractor may be mounted at an incorrect installation angle. This will cause the vehicle sensor to activate prematurely and not allow webbing payout. If this is the case then the sheet metal should be reworked to the correct shape and the retractor reinstalled.

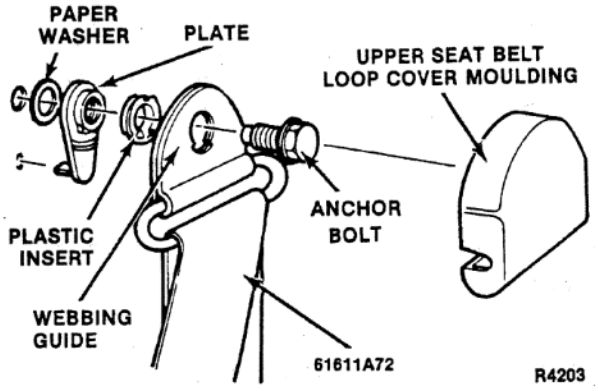
A 17 mm socket wrench, or equivalent, should be used for removal and installation of seat belt bolts on all seat belt assemblies.

REMOVAL AND INSTALLATION

FRONT SEAT BELT RETRACTOR AND BELT ASSEMBLY

Removal

1. Move the front seat forward and tilt the back rest into the rear passenger entry position to gain access to the retractor and belt assembly.
2. Remove the upper seat belt loop cover moulding. Remove the anchor bolt, complete with webbing guide, plate and paper retaining washer.



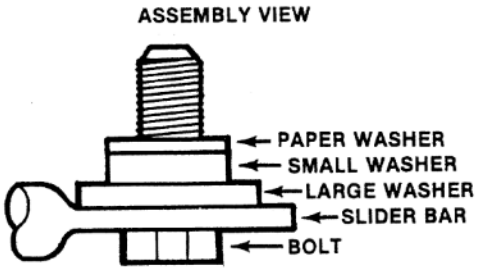
3. Remove the lower quarter trim panel. Remove the lock pillar upper trim. Remove the waist rail webbing guide to allow detachment of seat belt assembly.

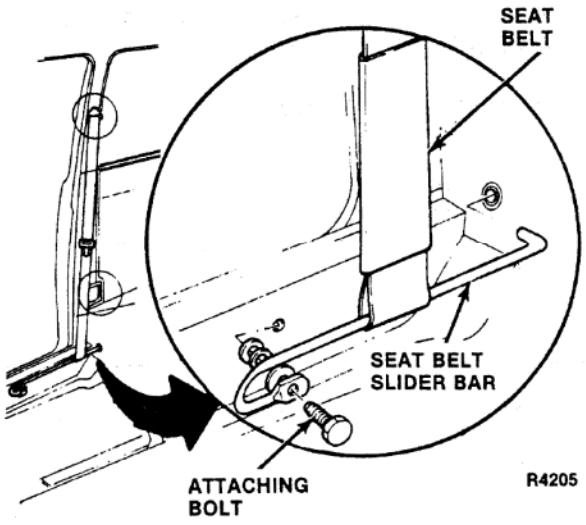
REMOVAL AND INSTALLATION (Continued)

FRONT SEAT BELT RETRACTOR AND BELT ASSEMBLY (Continued)

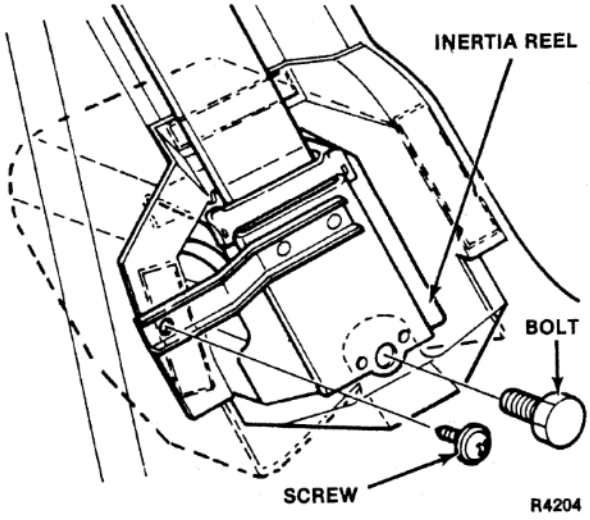
Removal (Continued)

4. Remove the bolt securing the seat belt slider bar to the floor pan side panel. Disengage bar from the heelkick panel. Slide the belt loop off the bar.





5. Remove the bolt and screw holding the inertia reel to the inner quarter panel. Remove the reel assembly.



Installation

NOTE: When fitting the retractor assembly, ensure that the belt does not become twisted.

1. Position the reel to the inner quarter panel with the locating pegs engaged in the retractor frame. Install the sheet metal screw through the seat belt anchorage plate and the bolt through retractor. Tighten the bolt to 28 to 40 N·m (21 to 30 lb-ft).
2. Extend the belt from the retractor to pass behind the waist rail webbing guide. Replace guide ensuring that no screws are driven through the webbing. Replace and fasten pillar trim. Attach the upper webbing guide assembly to the pillar. Tighten bolt to 28 to 40 N·m (21 to 30 lb-ft).

REMOVAL AND INSTALLATION (Continued)

FRONT SEAT BELT RETRACTOR AND BELT ASSEMBLY (Continued)

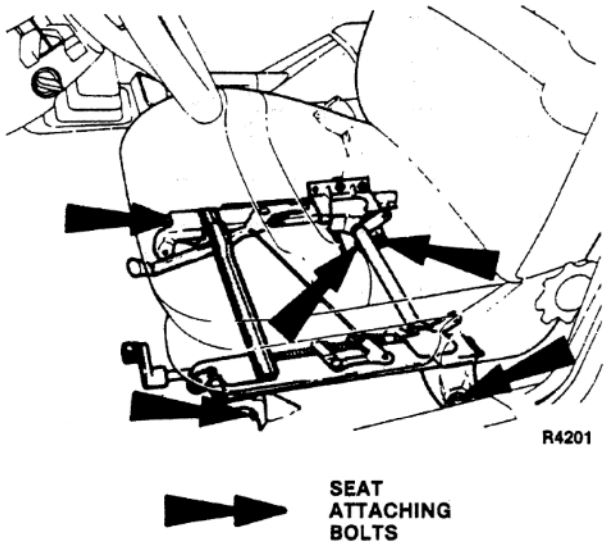
Installation (Continued)

3. Slip the belt loop around the adjuster bar, engage the slider bar with the heelkick panel and bolt the bar to the floor pan side panel. Tighten bolt to 28 to 40 N·m (21 to 30 lb-ft).
4. Test the operation of the seat belt assembly with the vehicle on level ground. The belt should run smoothly in both directions with no snagging.
5. Refit the lower quarter trim panel.

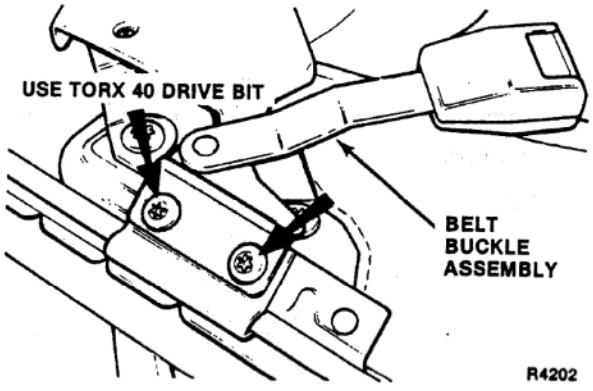
FRONT SEAT BUCKLE

Removal

1. Disconnect the battery. For vehicles with heated seats, disconnect both heated seat pad cables beneath the seat assembly. Disconnect the seat belt warning buzzer and lamp warning switch wire (driver's seat only).
2. Remove the five bolts securing the front seat to the floor pan.



3. Detach the belt buckle assembly by removing the two torx bolts.



REMOVAL AND INSTALLATION (Continued)

FRONT SEAT BUCKLE (Continued)

Installation

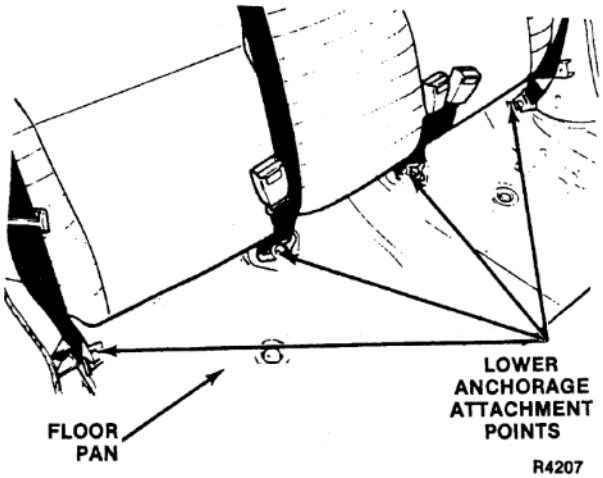
NOTE: There are three holes in the seat bracket on the seat sub-frame. The two rearward holes have "welded-on" nuts. Be sure you use these two holes when you install the seat belt buckle assembly and not the one without a weld nut.

1. Attach the seat belt buckle assembly to the seat bracket using the torx head screws. Tighten to 24 to 28 N·m (18 to 22 lb-ft).
2. Install the seat in the vehicle and reconnect the driver's seat warning switch wire, wire harness of the heated seat, if applicable, and battery cable. Tighten seat attachment bolts to 24 to 28 N·m (18 to 22 lb-ft).

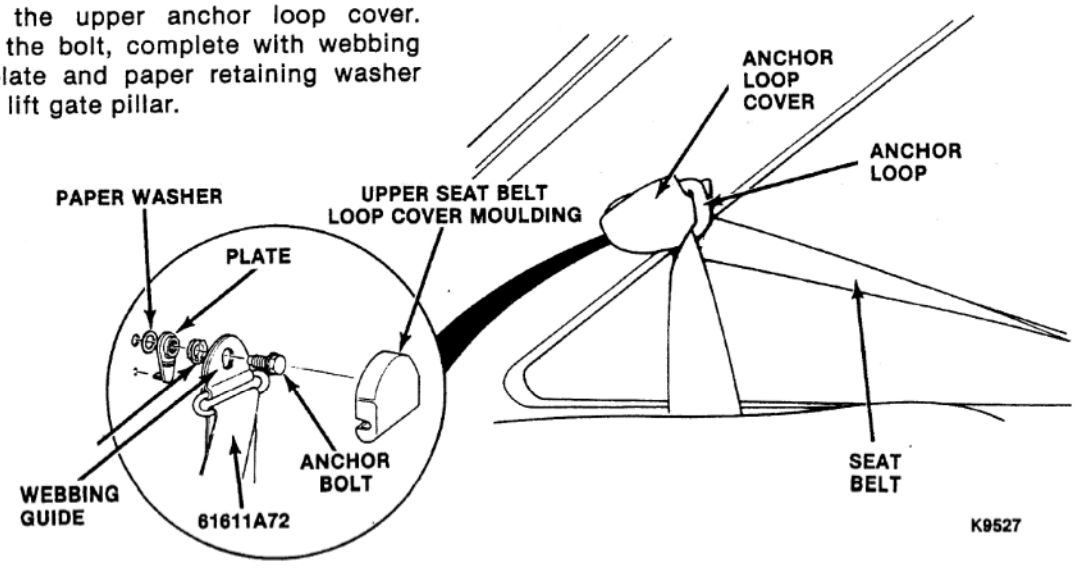
REAR SEAT BELT RETRACTOR AND BELT

Removal

1. Tilt the rear seat cushions forward to gain access to the lower anchorage floor pan securing bolts.
2. Remove the bolt securing the belt lower anchorage plate to the floor pan.



3. Remove the upper anchor loop cover. Remove the bolt, complete with webbing guide, plate and paper retaining washer from the lift gate pillar.

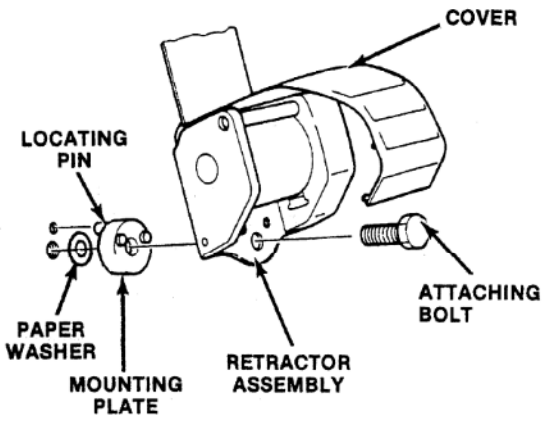


REMOVAL AND INSTALLATION (Continued)

REAR SEAT BELT RETRACTOR AND BELT (Continued)

Removal (Continued)

4. From within the liftgate compartment, lift up the inertia reel cover and remove the reel mounting bolt complete with retractor, mounting plate and paper washer.
5. Pry the belt guide runner from the rear parcel shelf support and push runner, upper anchorage loop, belt fastener, and lower anchorage plate down through the opening in the shelf.



Installation

NOTE: Be sure the belt does not become twisted during installation.

1. From within the liftgate compartment, extend the belt and slide the lower anchorage plate, belt fastener, webbing guide runner, and the upper anchorage loop through the opening in the rear parcel shelf.
2. Position the reel assembly to the mounting plate ensuring the locating pins engage in their holes. Install the mounting screw and tighten to 28 to 40 N·m (21 to 30 lb-ft). Refit the retractor cover.
3. Extend the belt and mount the upper anchorage loop to the inner quarter panel ensuring spacer pin locates in its hole. Tighten the bolt to 28 to 40 N·m (21 to 30 lb-ft). Refit the loop cover.
4. Feed belt through seat loop, install the lower anchorage plate to the floor and with one bolt and washer. Be sure the correct mounting hole and mounting plate position is used (Figure 6). Tighten to 28 to 40 N·m (21 to 30 lb-ft).
5. Push the belt guide runner into the opening of the rear parcel shelf. Return the rear seat cushion to its original position and install the belt retaining strap.
6. Test the operation of the seat belt assembly with the vehicle on level ground. The belt should run smoothly in both directions with no snagging.

REAR CENTER DOUBLE BUCKLE AND LAP BELT

Removal

NOTE: Two pieces of wire, approximately 3 mm diameter (1/8 in.) by 75 mm (3 in.) long are required to complete the following operation.

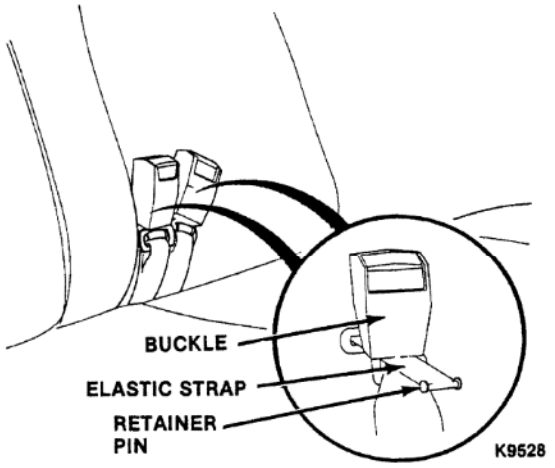
1. Fold rear seat cushion forward.

REMOVAL AND INSTALLATION (Continued)

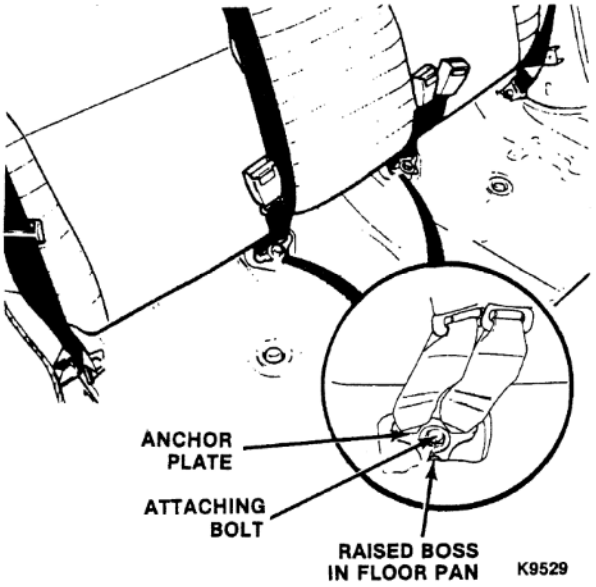
REAR CENTER DOUBLE BUCKLE AND LAP BELT (Continued)

Removal (Continued)

2. Remove the retaining pins from the elastic buckle straps and pull the elastic strap out of the buckle. Push the wire through the hole in the end of each elastic strap in order to prevent them from being lost inside the rear seat back assembly.



3. Remove the bolts attaching the buckle and belt anchor plates to the floor pan.



Installation

1. Position the double buckle assembly on the left-hand center floor anchorage. The double buckle assembly is installed on the right-hand center anchorage. Be sure the notch in the anchor plate locates on the raised boss.

   Tighten the attaching bolts to 25 to 45 N·m (21 to 30 lb-ft).

2. Remove the wire from the elastic straps. Position the straps through the buckles ensuring the buckle webbing is not twisted, and then install the strap retaining pins.

SECTION 41-60 SEAT TRIM AND HEATED SEAT

CONTENTS

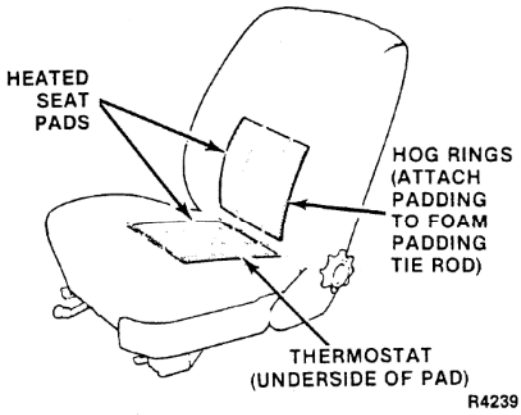
Page

DESCRIPTION

Heated Seat Pad 1

REMOVAL AND INSTALLATION

Back Cover, Front Seat 2
Cushion Cover, Front Seat 4
Cushion Cover, Rear Seat 4
Back Cover, Rear Seat 5
Heated Seat Cushion 6



DESCRIPTION

HEATED SEAT PAD

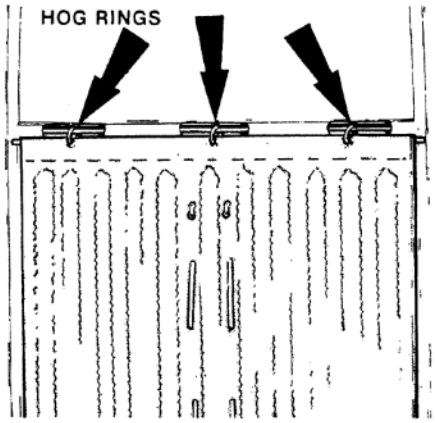
There are two heated seat pads: one fitted in the rear half of the seat cushion and the other in the lower half of the backrest.

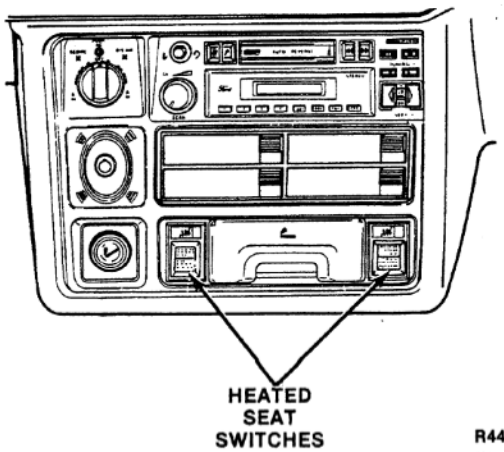
On the seat cushion, the pad is secured to the foam padding tie rods by six hog rings; three at the front and three at the rear. On the backrest, the pad is secured by three hog rings, the other end being taped to the foam in two places.

NOTE: If the seat trim covers are reinstalled, make sure that the pad is held flat; otherwise, a short circuit in the heating elements of the pad could result. This could cause damage to the seat trim or foam.

The heated seats are controlled by switches housed in the instrument panel near the ash tray. The power supply to both seat pads passes through a relay to the heated seat switch. A wiring harness connects the switch to both wire pads. Each wire pad is connected to the harness by a push-snap connector.

The switches have two positions: ON and OFF. When the switch is "ON," the heating pads will warm up to their maximum temperature of 113 °F (45 °C) in 4 to 6 minutes. The heating element will then turn off until the temperature reaches a





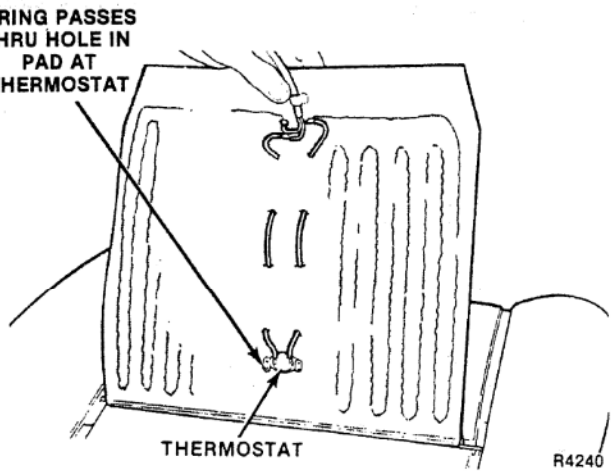
DESCRIPTION (Continued)

HEATED SEAT PAD (Continued)

temperature of 72°F (22°C) at which time the pads will cycle on again. The cycle will continue until either the switch or ignition turns off.

The power supply to both seat pads passes through a relay (located behind the instrument cluster) to the heated seat switch. A wiring harness connects the switch to both pad wires. Each of the pad wires is connected to the wiring harness by a harness connector located behind the seat.

The circuit operation is controlled by a thermostat built into the pad. The thermostat is on the underside of the pad, facing the seat foam, not the seat trim. The electrical circuit will operate when the ignition is in the II (On) position and will also operate in the accessory position (Position I).



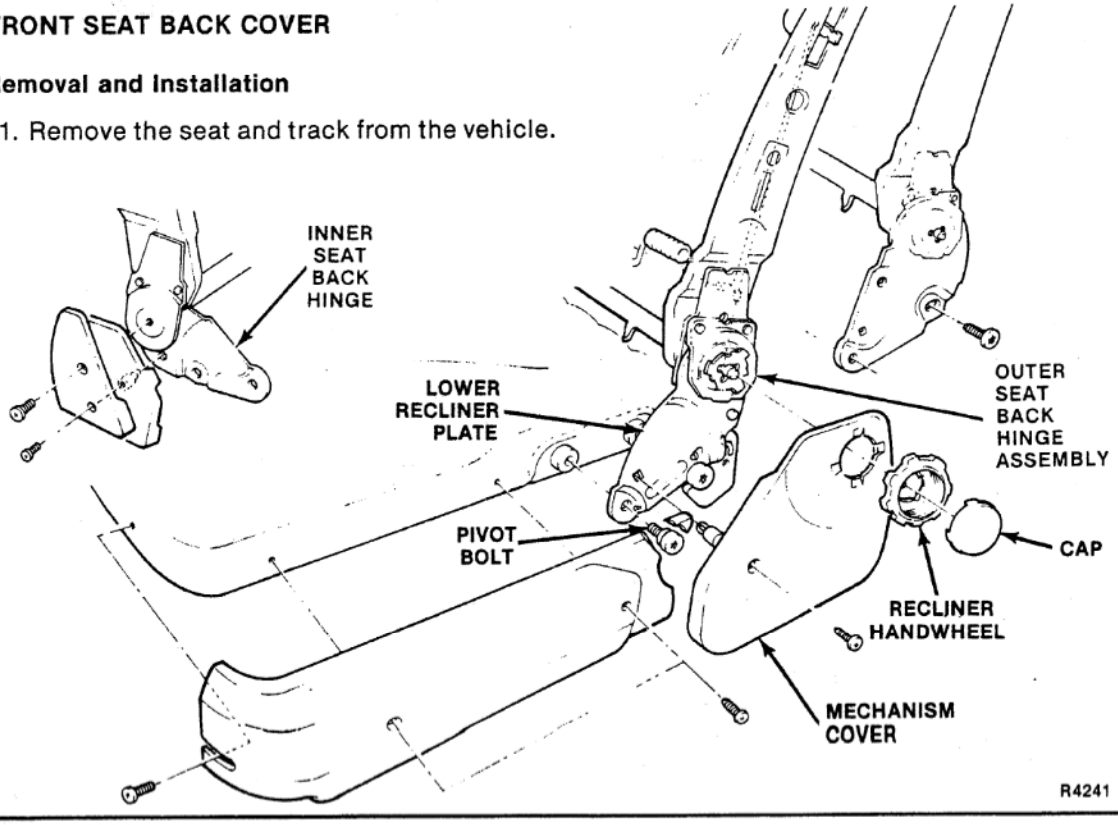
NOTE: When the heated seats are being operated in the I position, there will be a heavy drain on the battery.

REMOVAL AND INSTALLATION

FRONT SEAT BACK COVER

Removal and Installation

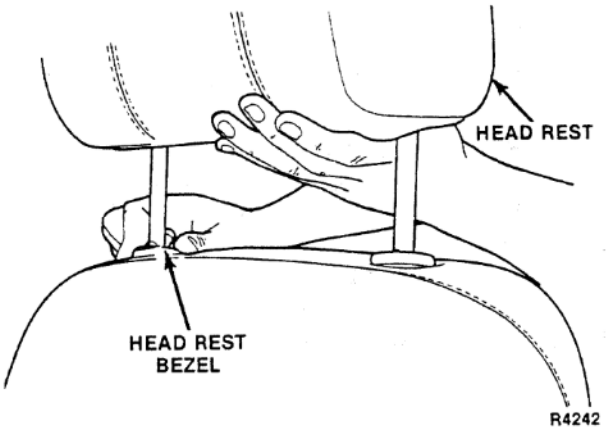
1. Remove the seat and track from the vehicle.



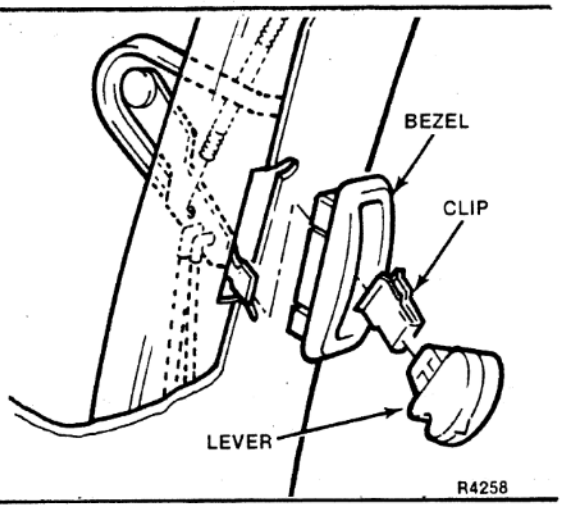
REMOVAL AND INSTALLATION (Continued)

FRONT SEAT BACK COVER (Continued)

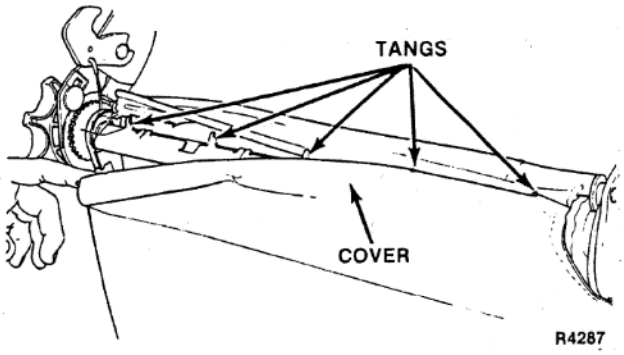
2. Remove recliner handwheel by removing cap (pry off using suitable screwdriver) and rotating spring clip within handle recess.
3. Remove inner and outer mechanism plastic covers.
4. Remove pivot bolt located in front of lower recliner plate.
5. Remove headrest and headrest bezel. Raise head restraint to fully upward position. Depress the release button on the right-hand sleeve and simultaneously pull the head restraint up and out of the sleeves. Remove the bezels by rotating 90 degrees counterclockwise and then pulling the bezel upward.



6. Remove front seat back latch bezel, clip and lever.



7. Lift tangs which fix the lower edges of the seat cover to the seat frame and pull cover off the tangs.
8. Lift cover while disengaging hooks on retainers on both sides of the seat.
9. Lift cover further off seat and cut any hog rings fixing tie-down retainers to the seat back.



Installation

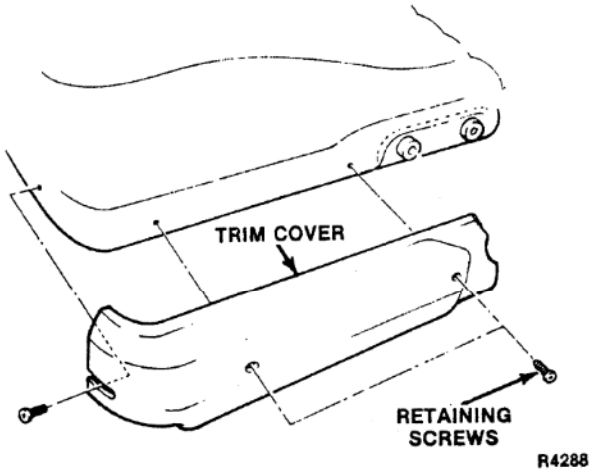
1. Reverse removal procedures.

REMOVAL AND INSTALLATION (Continued)

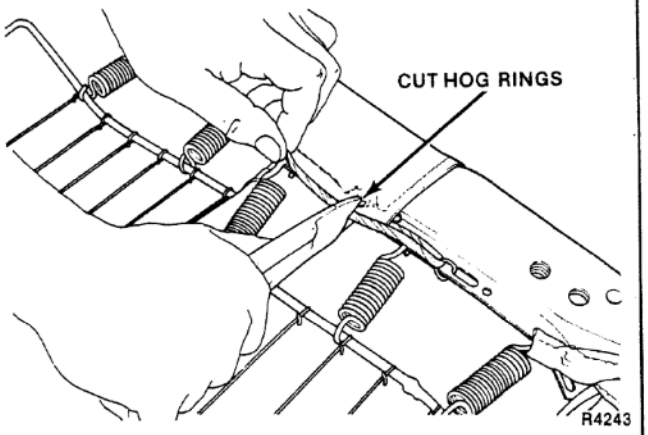
FRONT SEAT CUSHION COVER

Removal and Installation

1. Remove the seat and track assembly from the vehicle.
2. Remove the seat track from the seat cushion by removing the two bolts on each track and remove the two front seat back hinge assemblies.
3. Remove seat back from seat cushion (refer to seat back cover removal as necessary).
4. Remove trim cover and three retaining screws.



5. Cut the hog rings from the cushion cover at the seat cushion flange. Remove tie-down hog rings across center of seat cushion cover and remove cover.



6. To install, reverse removal procedures. Pull and fix cords under cushion to tension cover.

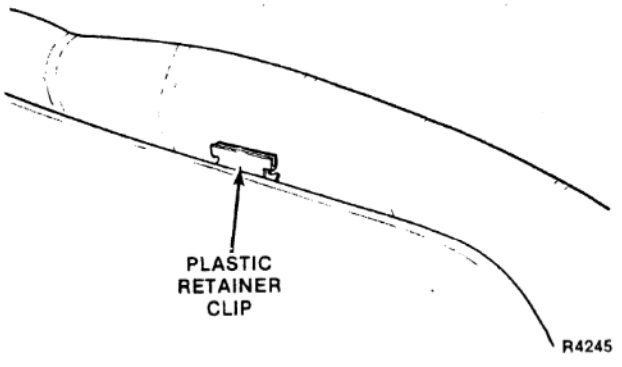
REAR SEAT CUSHION COVER

Removal

1. Remove the rear seat cushion from the vehicle.
2. Disengage the plastic retainer clips from the seat cushion flange and cut the hog rings. Remove the cover from the cushion.

Installation

1. Position the cover over the cushion assembly. Attach cover to pad with hog rings. Fit the plastic retainer clips to the seat flange assembly.
2. Install the cushion assembly into the vehicle.

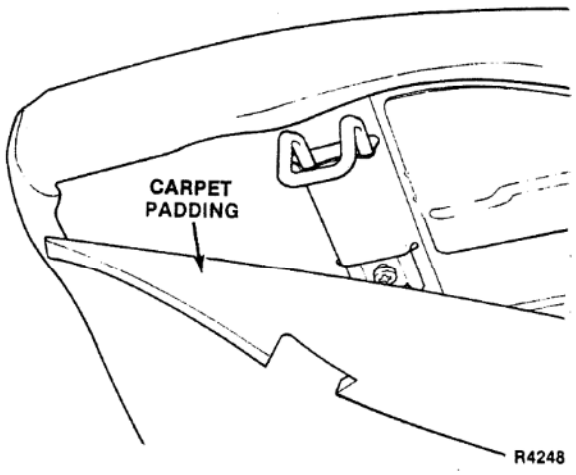


REMOVAL AND INSTALLATION (Continued)

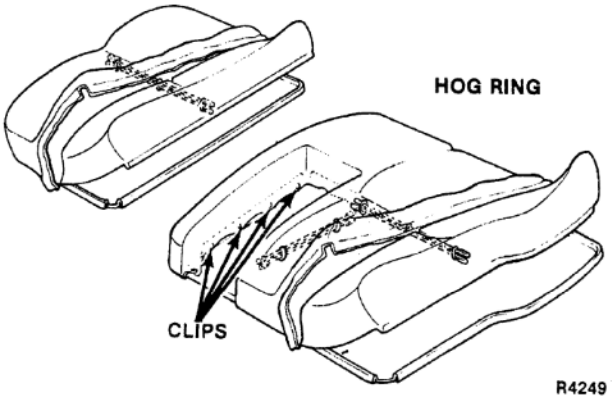
REAR SEAT BACK COVER

Removal

1. Remove the rear seat back assembly from the vehicle.
2. Remove carpet from seat back.
3. Remove armrest assembly.

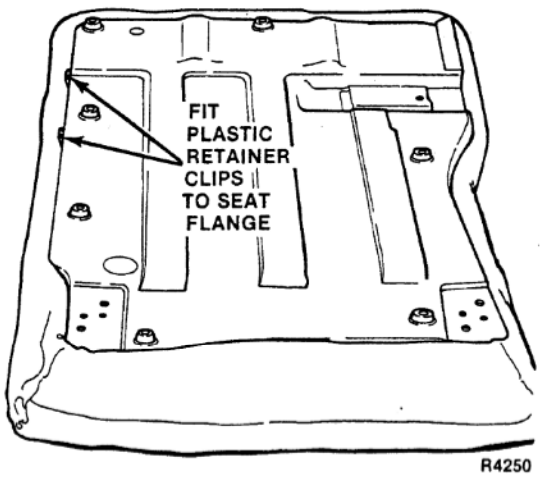


4. Disengage the plastic retainer clips from the seat back flange and remove the cover/ pad from the seat back.
5. Cut hog rings to separate cover from pad.



Installation

1. Position cover over seat back assembly.
2. Attach cover to back pad with hog rings.
3. Fit plastic retainers to the seat flange assembly.
4. Install seat back assembly into vehicle.
5. Adjust striker assembly to ensure engagement with catch.
6. Install carpet.

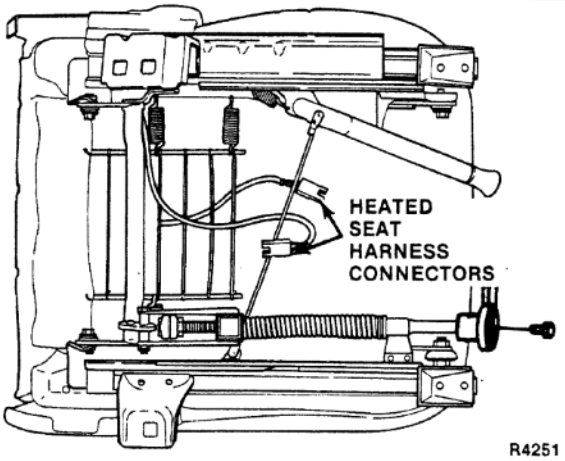


REMOVAL AND INSTALLATION (Continued)

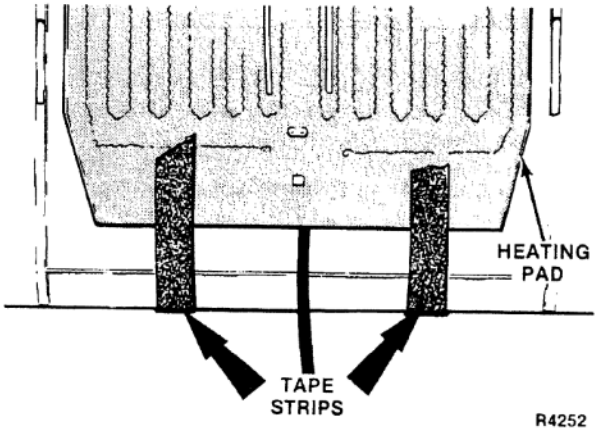
HEATED SEAT CUSHION

Removal

1. Disconnect the two electrical connectors beneath the seat.



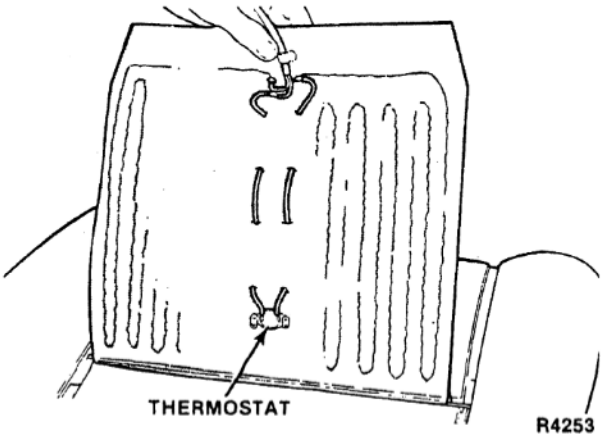
2. Remove the seat cushion as detailed earlier in this section.



3. Remove the hog rings holding heating pad and pad tie rod to cushion seat rod.
4. Remove and slide tie rod from pad slot.

Installation

1. Slide the tie rod into pad slot.
2. Position pad on foam cushion with thermostat facing foam.



3. Attach pad and pad tie rods to cushion tie rod with six new hog rings.
4. Reinstall seat cushion trim as detailed.
5. Reconnect the two electrical connectors beneath the seat.

WINDOW GLASS MECHANISMS

GROUP 42 (20000)

TITLE SECTION	PAGE NO.	TITLE SECTION	PAGE NO.

WINDOW GLASS 42-01

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LUBRICATION 2
TESTING
- Power Window Motor Test 2
- Power Window Switch Test 3

ADJUSTMENTS
- Glass 3

DIAGNOSIS
- Both Windows Fail to Operate 4
- One Window Does Not Operate 4

REMOVAL AND INSTALLATION
- Door Glass 4
- Run and Bracket Assembly 6
- Manual Window Regulator 7
- Window Operating Motor 8
- Power Window Regulator 10
- Power Window Relay 12
- Window Operating Switch 12

MIRRORS—MANUAL 42-12

REMOVAL AND INSTALLATION
- Inside Rear View Mirror 1

MIRRORS—POWER 42-15

DESCRIPTION 1
DIAGNOSIS
- Both Mirrors Do Not Operate 2
- One Mirror Does Not Work 2

REMOVAL AND INSTALLATION
- Power Mirror Assembly 2
- Mirror Glass 4

PIVOT TYPE QUARTER WINDOW 42-33

REMOVAL AND INSTALLATION
- Glass 1

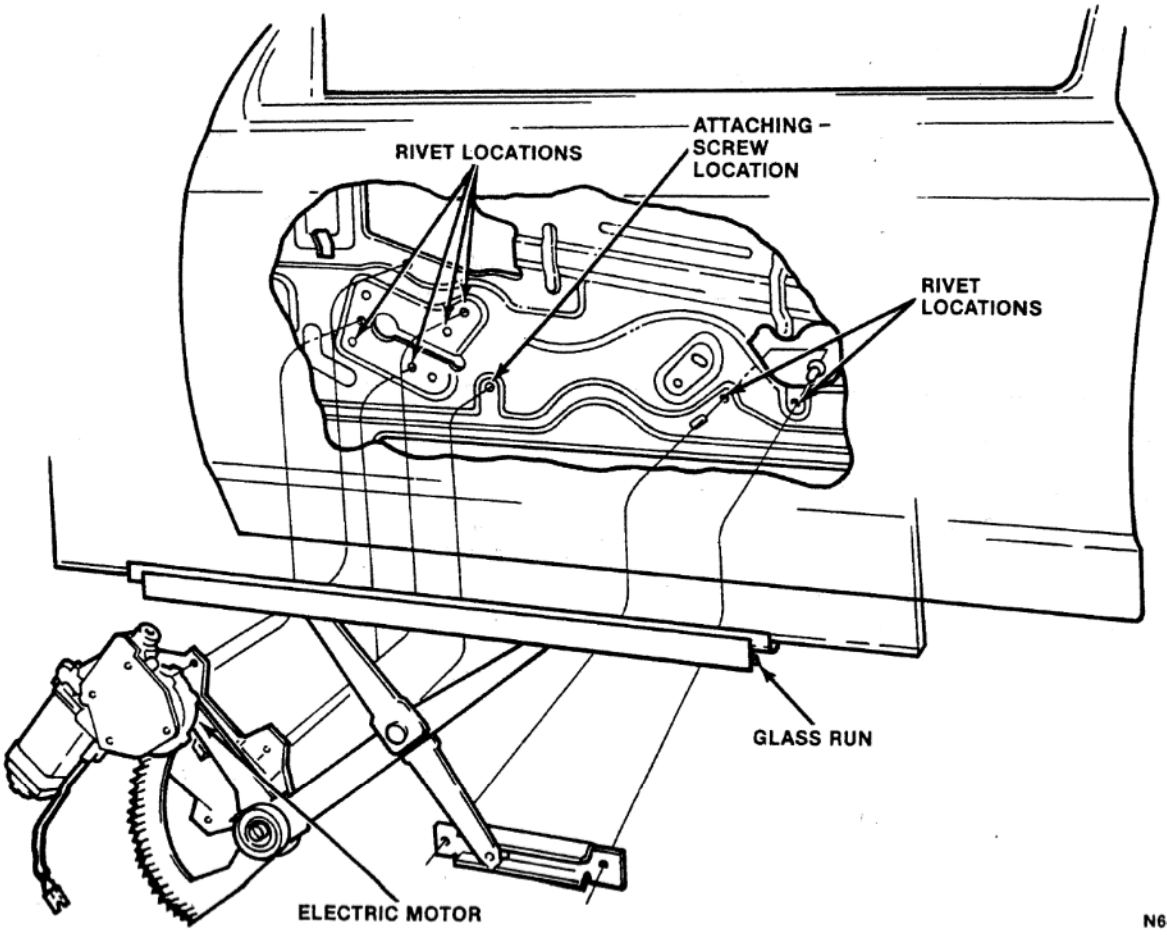
REAR QUARTER WINDOW—STATIONARY 42-38

DESCRIPTION 1
REMOVAL AND INSTALLATION
- Rear Quarter Window 2

SECTION 42-01 WINDOW GLASS

CONTENTS

	Page
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Power Window Switch Test	3
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Glass	3
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Both Windows Fail to Operate	4
One Window Does Not Operate	4
REMOVAL AND INSTALLATION	
Door Glass	4
Run and Bracket Assembly	6
Manual Window Regulator	7
Window Operating Motor	8
Power Window Regulator	10
Power Window Relay	12
Window Operating Switch	12



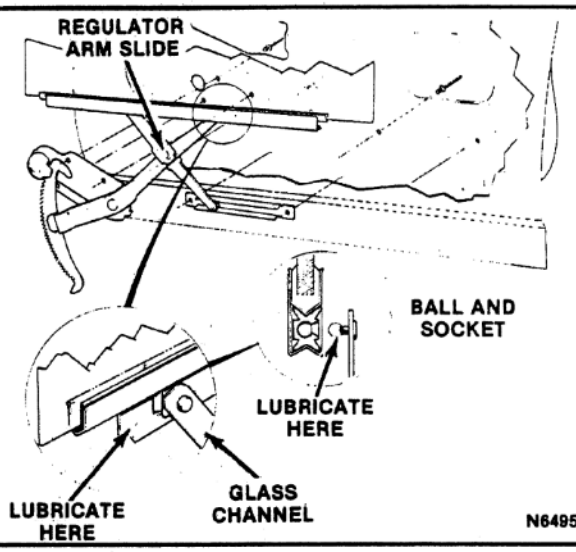
DESCRIPTION

Optional power door windows are regulated by an electric motor. When the ignition is OFF, the system carries no power. When the ignition is ON, power is provided through an auxillary relay located in the brake pedal support to both terminals of the window's electric motor. The motor is protected by fuse No. 1 located in the fuse box in the engine compartment.

The operating motor is riveted into the inner side of the door panel. It is equipped with a circuit breaker that senses window movement resistance and switches the motor off before it is damaged. The motor is accessible only after removing the door trim panel.

LUBRICATION

The door window mechanism should be well lubricated to provide ease of operation. The window glass mechanism should be lubricated whenever the glass channel or window regulator is removed or excessive effort is required to operate the windows. To lubricate a door window mechanism, apply an even coating of polyethylene grease, DOAZ-1954-A or equivalent to the window regulator roller, shafts and the entire length of the roller guides as illustrated.

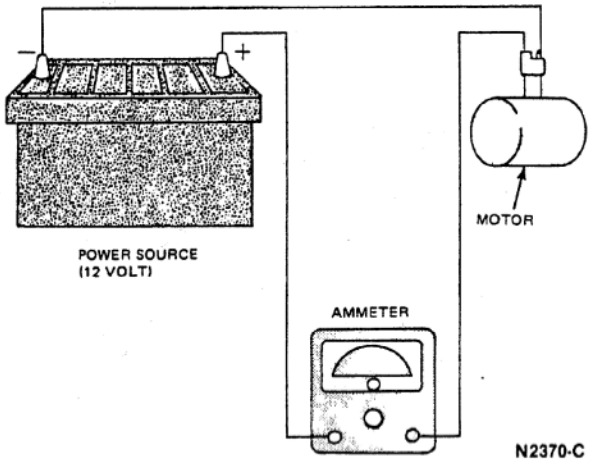


TESTING

POWER WINDOW MOTOR TEST

NOTE: To test the current draw of a power window motor, remove the motor as described in this section.

1. Connect an external power source to the motor with an ammeter in series.



TESTING (Continued)

POWER WINDOW MOTOR TEST (Continued)

2. Operate the motor and observe the current draw. The current draw for the no-load test should not exceed specifications and should not fluctuate. Reversal of the motor wire connections will reverse the direction of motor rotation. Replace the motor if the current draw exceeds 5 amps at 12.8 volts.

POWER WINDOW SWITCH TEST

NOTE: Testing of the power window switch should be performed with the switch removed from the vehicle. Use a self-powered test lamp or an ohmmeter.

1. With the switch in the neutral position, there should be continuity between terminals 3-1/3-2/3-9/3-10.
2. With the left rocker switch pushed down at bottom, there should be continuity between terminals 3-2/3-9/3-10/4-1. With the right rocker switch pushed down at bottom, there should be continuity between terminals 3-1/3-2/3-10/4-9.
3. With the left rocker switch pushed down at top, there should be continuity between terminals 3-1/3-9/3-10/4-2. With the right rocker switch pushed down at top, there should be continuity between terminals 3-1/3-2/3-9/4-10.
4. If the switch does not test as stated, replace the switch.

ADJUSTMENTS

GLASS

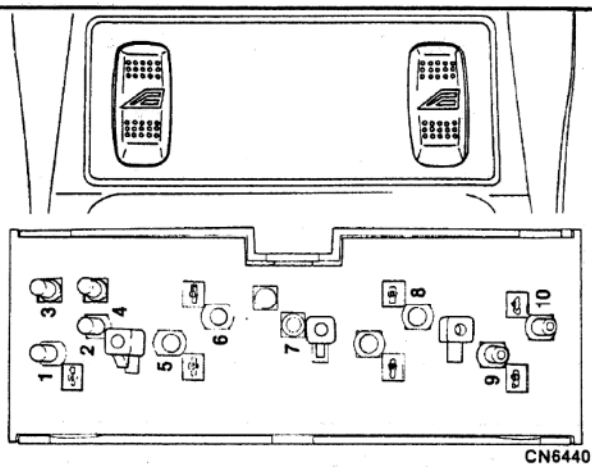
1. Remove door trim panel and watershield.
2. Loosen glass channel run by loosening the screw at the bottom.
3. Lower the glass to approximately mid-position between the full-up and full-down positions. Set the glass forward until it bottoms against the run assembly within the front door frame.
4. Position the glass run channel forward to the glass and tighten the run and bracket assembly bottom screw.
5. Cycle the door glass to assure smooth operation during the up/down cycle.

DIAGNOSIS

BOTH WINDOWS FAIL TO OPERATE

1. Check fuse.
2. Check voltage at the rocker harness connector.

TEST SWITCH	NORMAL POSITION
1	GRD
2	GRD
3	GRD IN
4	POWER IN (12v)
9	GRD
10	GRD



CN6440

NOTE: Battery voltage should be available at both outer terminals of each plug when the ignition is ON and the rocker switch is in the rest position. The center terminal is always connected to ground. When the rocker switch is turned ON, the respective outer terminal of the switch will also be connected to ground.

3. Check the wiring harness for defects and repair as necessary.

ONE WINDOW DOES NOT OPERATE

1. Check voltage at the rocker switch harness connector.
2. Check voltage at the wiring connections to the motor inside the door handle.

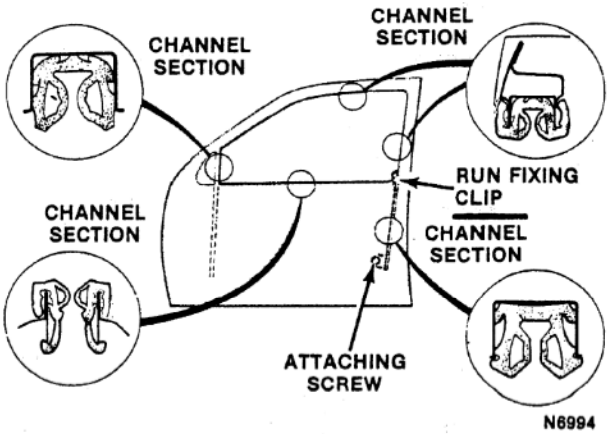
NOTE: With the ignition switch ON and the rocker switch in the central position, both terminals on the motor should have a positive feed. When the switch is activated, one terminal should become disconnected from a positive feed and become connected to a negative feed. Which terminal is positive and which is negative depends upon the direction in which the rocker switch is actuated.

REMOVAL AND INSTALLATION

DOOR GLASS

Removal

1. Remove door trim panel and watershield. Refer to Section 45-03.
2. (Driver's Door Only) Remove power mirror assembly. Refer to Section 42-15.
3. Remove attaching screw and unclip door glass run extension.

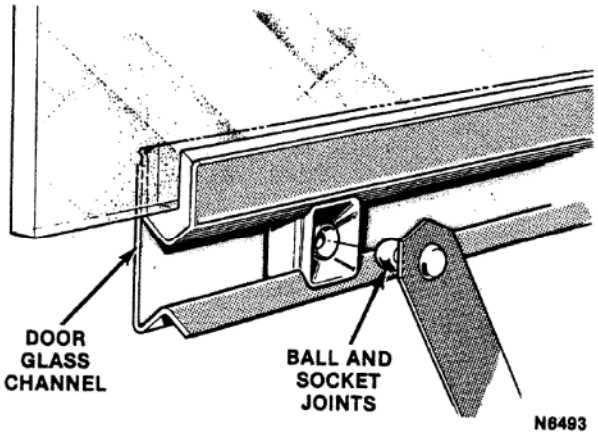


N6994

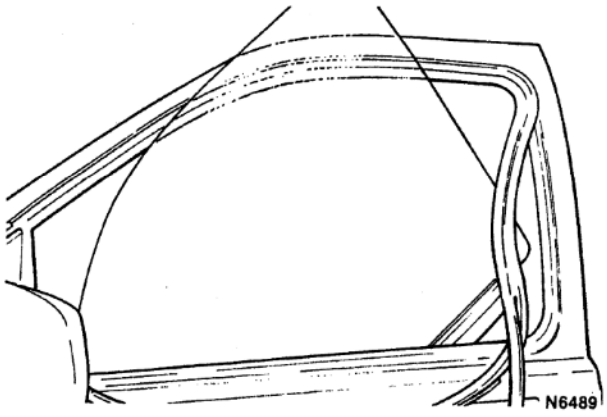
REMOVAL AND INSTALLATION (Continued)

DOOR GLASS (Continued)

4. Lower window until ball and socket joints connecting window bracket to regulator are visible through lower door aperture. Separate ball and socket joints and lower window to bottom of door.



5. Detach window weatherstrip from rear half of window aperture. Remove glass from exterior of vehicle.



Installation

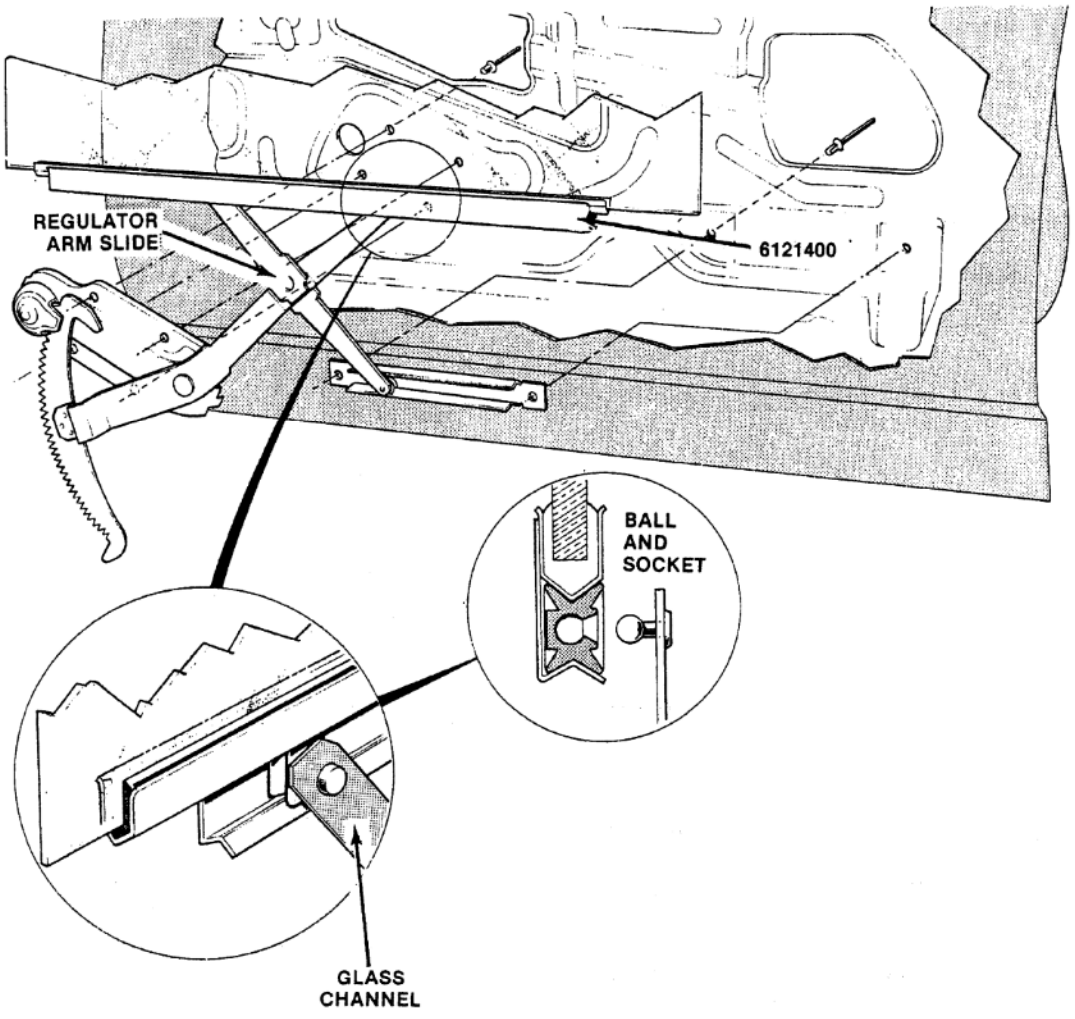
1. Install glass into door and reconnect regulator to sockets in window channel. Reinstall window weatherstrip to rear half of door aperture.
2. Raise window and install door glass extension run with upper clip and lower screw. The retaining screw should be tightened to give the glass a minimum of 5 mm (0.2 in.) fore/aft clearance.
3. Install the power mirror assembly. Refer to Section 42-15.
4. Reinstall the weathershield and door trim panel. Refer to Section 45-03.

REMOVAL AND INSTALLATION (Continued)

RUN AND BRACKET ASSEMBLY

Removal

1. Remove door trim panel and watershield.
2. Support the glass in the full-up position.
3. Remove upper and lower attaching hardware from glass run.
4. Remove the regulator arm slide from the glass bracket C-channel and remove the run and bracket assembly from the door.



REMOVAL AND INSTALLATION (Continued)

RUN AND BRACKET ASSEMBLY (Continued)

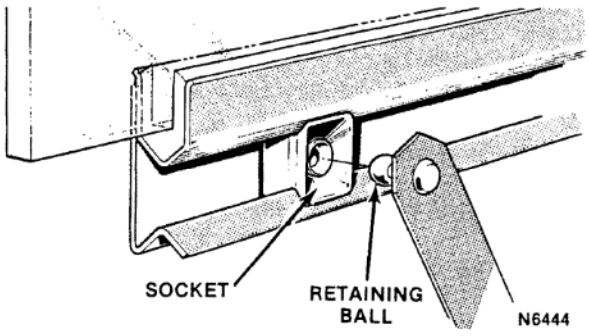
Installation

1. Install the glass bracket assembly onto the glass run and position them in the door.
2. Loosely install the upper and lower run attaching hardware.
3. Insert regulator slide into glass bracket C-channel.
4. Remove the glass prop and position the glass bracket to the glass.
5. Adjust glass as outlined in Adjustments section.
6. Cycle the glass to check for proper operation.
7. Install the door trim and watershield.

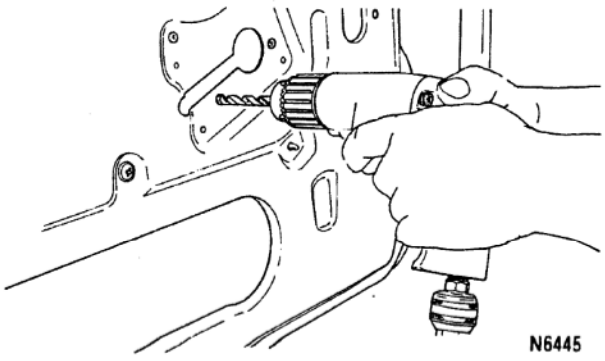
MANUAL WINDOW REGULATOR

Removal

1. Remove door trim panel and watershield.
2. Lower the glass to the pull-down position. Separate regulator from glass by pulling retaining balls on regulators from sockets in channel rollers.



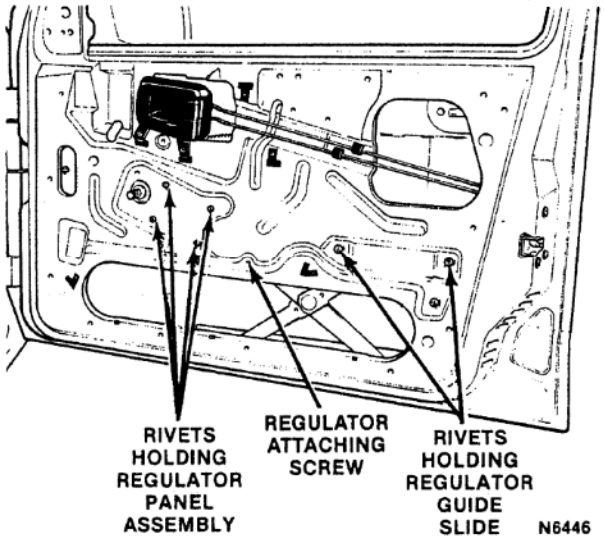
3. Drill out four rivets holding regulator panel assembly and two rivets holding the regulator guide slide.



REMOVAL AND INSTALLATION (Continued)

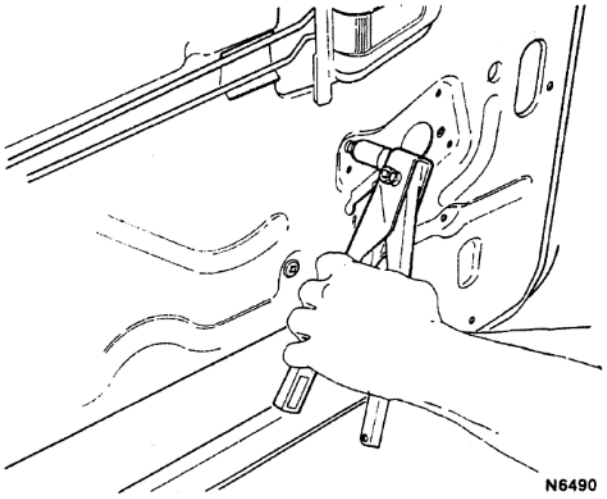
MANUAL WINDOW REGULATOR (Continued)

4. Remove regulator attaching screw.
5. Remove regulator through lower door opening.



Installation

1. Insert regulator through lower door opening. Install four rivets to hold regulator pivot assembly and two rivets to hold slide guide.
2. Position rollers and regulator attaching screw in glass channel. Push balls on regulator into sockets on glass channel rollers.
3. Install watershield and trim panel. Refer to Section 45-03.



WINDOW OPERATING MOTOR

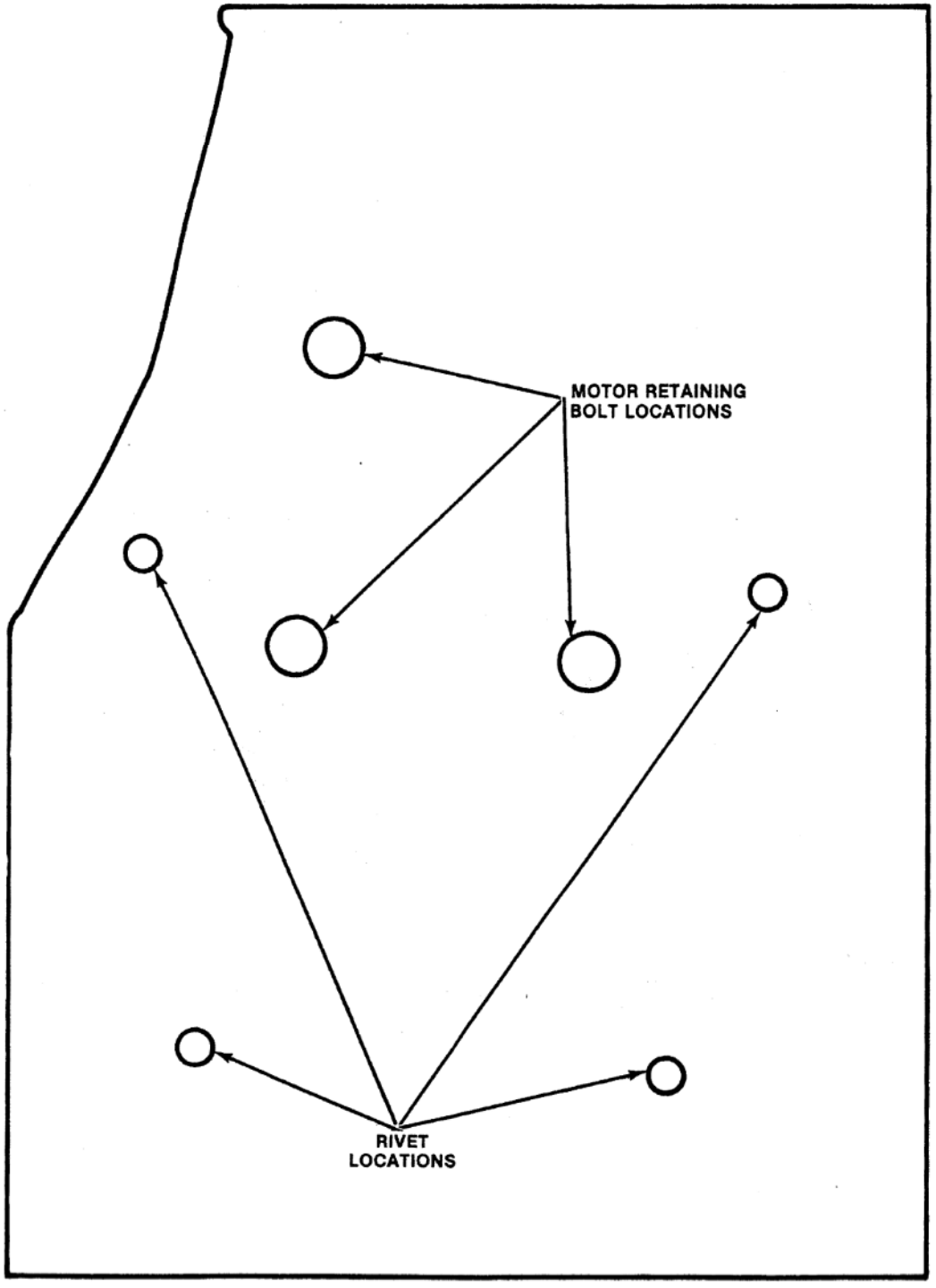
Removal

1. Raise the window to the full-up position if possible.
2. Disconnect the battery ground cable.
3. Remove door trim panel and watershield. Refer to Section 45-03.
4. Disconnect window motor connector.

REMOVAL AND INSTALLATION (Continued)

WINDOW OPERATING MOTOR (Continued)

5. Position copy of template shown below and mark position of three window motor retaining bolt holes with a punch. Drill out 3/4-inch holes.



REMOVAL AND INSTALLATION (Continued)

WINDOW OPERATING MOTOR (Continued)

6. Remove three window motor retaining bolts.
7. Push motor toward outside sheet metal to disengage the motor and drive assembly from the drive gear.
8. Remove motor from inside door.

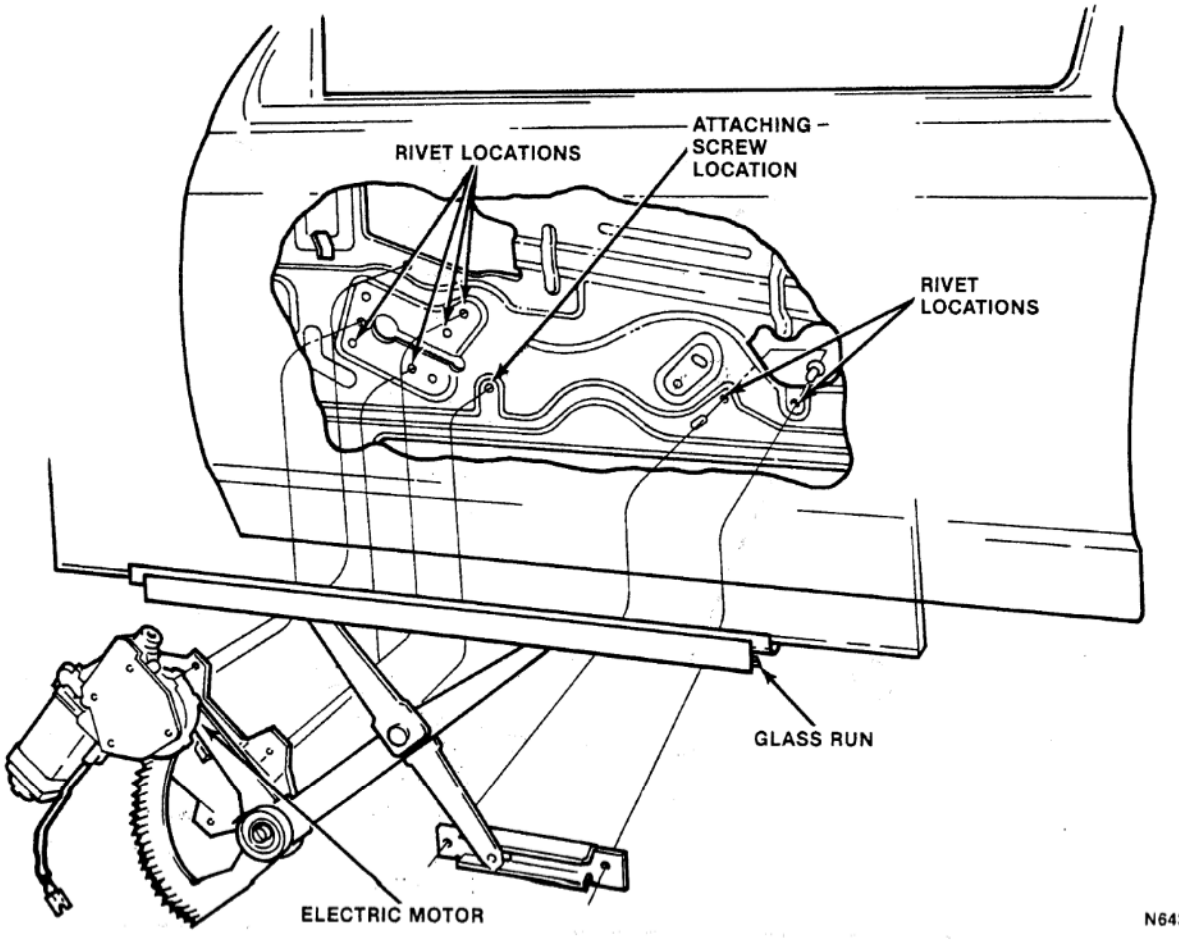
Installation

1. Install motor and three window motor retaining bolts.
2. Connect the motor wiring connector and check window for correct operation.
3. Install the door trim panel and watershield. Refer to Section 45-03.

POWER WINDOW REGULATOR

Removal

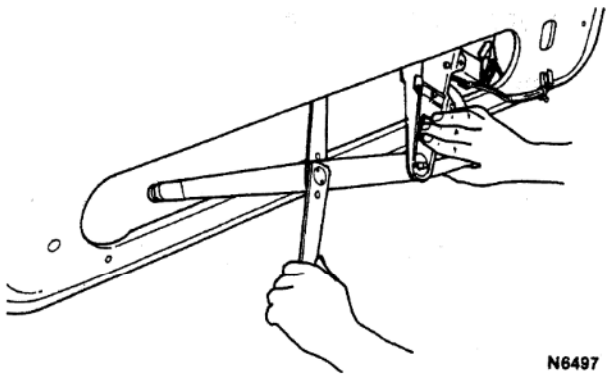
1. Remove door trim panel and watershield.
2. Raise the glass to a full up position if possible and then prop the glass.
3. Disconnect the power motor wiring connector.
4. Remove the four rivets attaching the regulator to the inner door panel and the two rivets holding the regulator guide slide. Remove the center pin from each rivet. Then, using a ¼-inch drill, drill out the remainder of the rivet taking care not to enlarge the sheet metal retaining holes.



REMOVAL AND INSTALLATION (Continued)

POWER WINDOW REGULATOR (Continued)

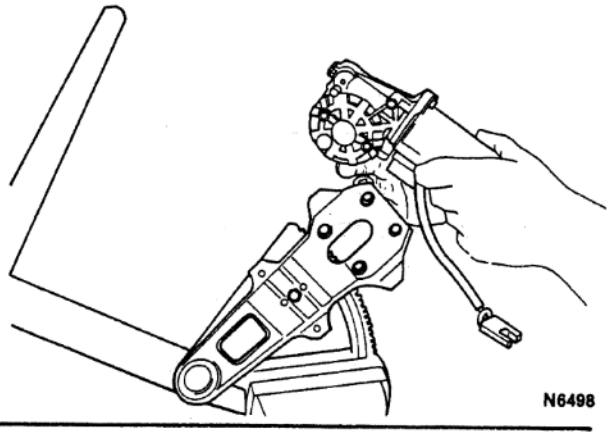
5. Remove the regulator attaching screw.
6. Remove the regulator through the lower door opening.


N6497

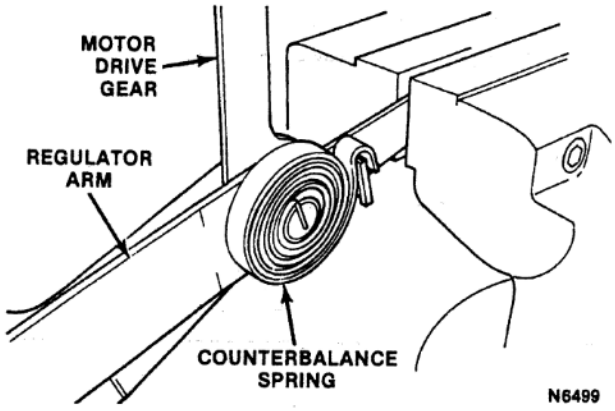
7. To remove the window regulator arm from the drive gear, first mount the regulator in a vise.

CAUTION: The regulator arm is affixed to the motor drive gear by a counterbalance spring loaded under high pressure.

8. Remove the three window motor retaining bolts and remove the motor from the drive gear.


N6498

9. Remove the regulator arm stop that maintains tension. Do this by holding the regulator arm while allowing the counterbalance spring to unwind. Unhook the counterbalance spring to the regulator arm and remove the regulator.



N6499

Installation

1. Hook counterbalance spring to the motor drive gear.
2. Install the motor on the regulator arm.
3. Insert regulator through lower door opening. Install four rivets to hold regulator pivot assembly and two rivets to hold slide guide.
4. Position rollers and regulator attaching screw in glass channel. Push balls on regulator into sockets on glass channel rollers.
5. Connect electric motor wiring.
6. Install watershield and trim panel. Refer to Section 45-03.

REMOVAL AND INSTALLATION (Continued)

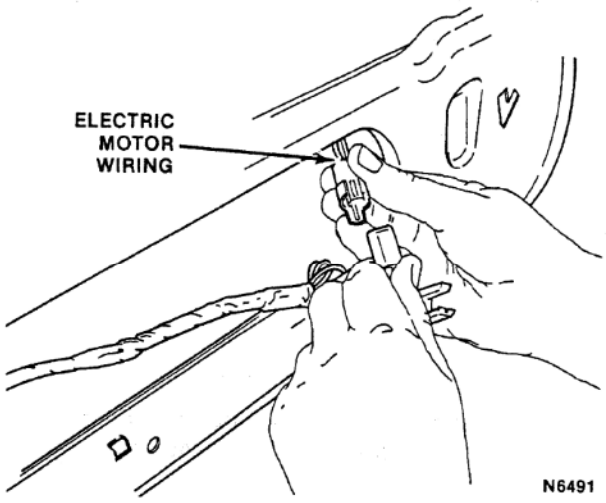
POWER WINDOW RELAY

Removal

1. Disconnect the ground cable from the battery.
2. Remove the underdash cover. Unclip relay.
3. Disconnect wiring connector from relay and remove relay.

Installation

1. Reconnect wiring connector to relay and install relay.
2. Install underdash cover.
3. Reconnect battery ground cable.



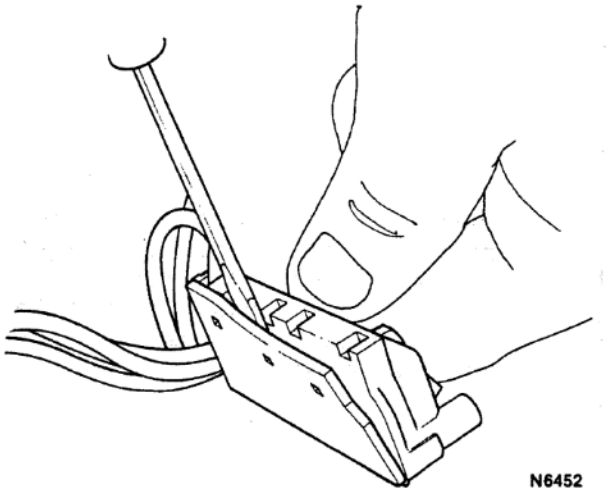
WINDOW OPERATING SWITCH

Removal

1. Disconnect the ground cable from the battery.
2. Use a screwdriver to pry the switch from the front console clips.
3. Disconnect harness connector.

Installation

1. Connect wiring connector. Install switch in console.
2. Reconnect battery ground cable.
3. Check operation of the switch.



SECTION 42-12 MIRRORS—MANUAL

CONTENTS

Page

REMOVAL AND INSTALLATION

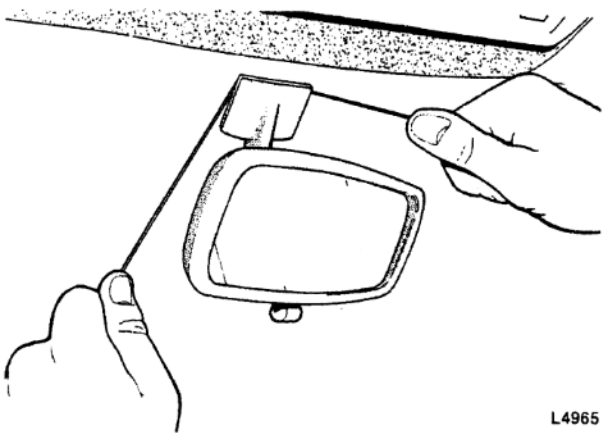
Inside Rear View Mirror 1

REMOVAL AND INSTALLATION

INSIDE REAR VIEW MIRROR

Removal

Break the adhesive bond between the mirror stem and adhesive patch on the window with a thin nylon cord. Remove the mirror.

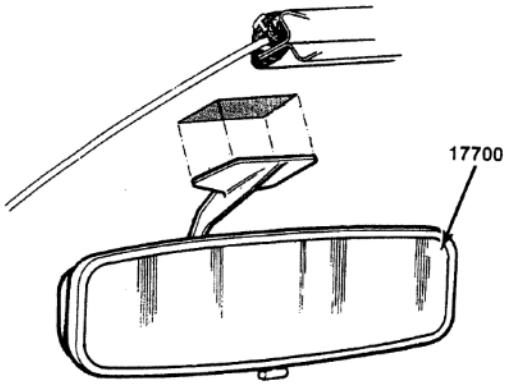


L4965

Installation

NOTE: When installing an inside rear view mirror to a new windshield, first remove the protective tape from the windshield adhesive patch.

1. Remove any residue of adhesive tape from the mirror mount with a lint-free cloth and methylated alcohol. Allow one minute to dry.
2. Warm the mirror base and adhesive patch to a temperature of 122 to 158 °F (50 to 70 °C).
3. Remove the protective tape from the adhesive patch on mirror and press onto windshield mount. Hold in place for two minutes.
4. Wait for thirty minutes and check adjustment and function of mirror.



L4964

SECTION 42-15 MIRRORS—POWER

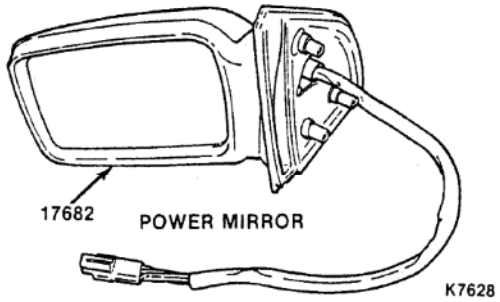
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DESCRIPTION 1

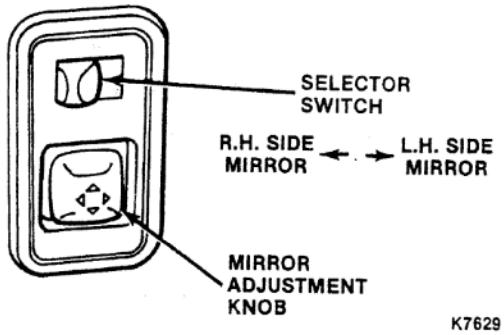
DIAGNOSIS
- Both Mirrors Do Not Operate 2
- One Mirror Does Not Work 2

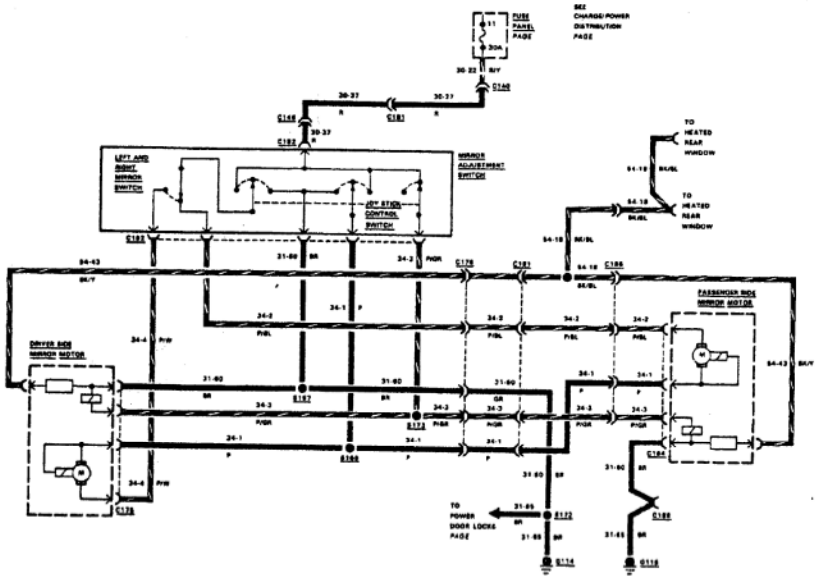
REMOVAL AND INSTALLATION
- Power Mirror Assembly 2
- Mirror Glass 4



DESCRIPTION

Electrically powered outside rearview mirrors are standard on the XR4Ti. The switch for controlling adjustments is located on the driver's door. A selector switch determines operation of either the right-hand or left-hand mirror while an adjustment knob tilts the mirror up, down, left, and right by moving the knob in the direction of the appropriate arrow marked on the adjustment knob.





POWER MIRROR SWITCH ELECTRICAL SCHEMATIC

DIAGNOSIS

BOTH MIRRORS DO NOT OPERATE

- Check Fuse 11 by operating Remote Liftgate Release.
- Remove driver's door trim panel. Check for voltage at C146 in circuit 30-37 using a known good ground.

If no power, check circuit 30-37 back to fuse. If there is power, check circuit 31-60 (BK wire) from C182 to ground G114. If circuit 31-60 is OK, check Power Mirror Switch.

ONE MIRROR DOES NOT WORK

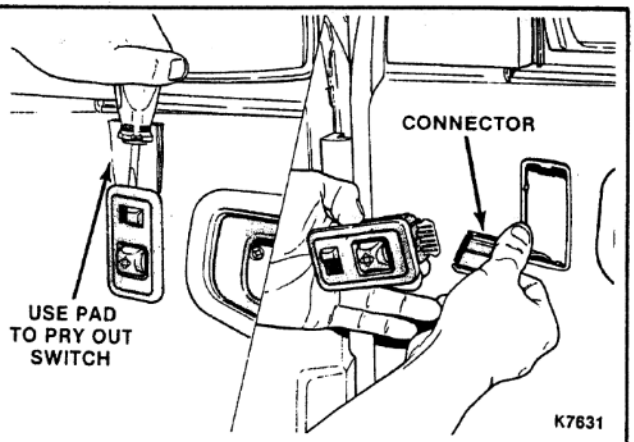
- Check left mirror-right mirror switch.
- Check that in-line connectors are tight.

REMOVAL AND INSTALLATION

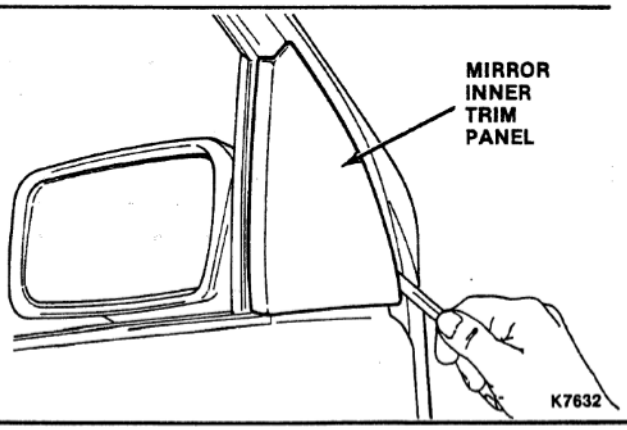
POWER MIRROR ASSEMBLY

Removal

1. Disconnect battery ground cable.
2. Use a screwdriver cushioned by a pad to pry out power mirror switch. Disconnect power mirror switch electrical connector.
3. Remove door trim panel.
4. Disconnect mirror switch wiring connector.



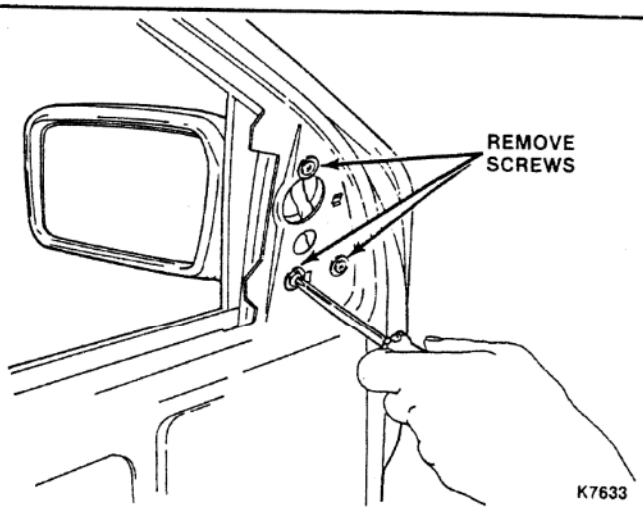
5. Carefully pry off mirror inner trim cover to release clip.



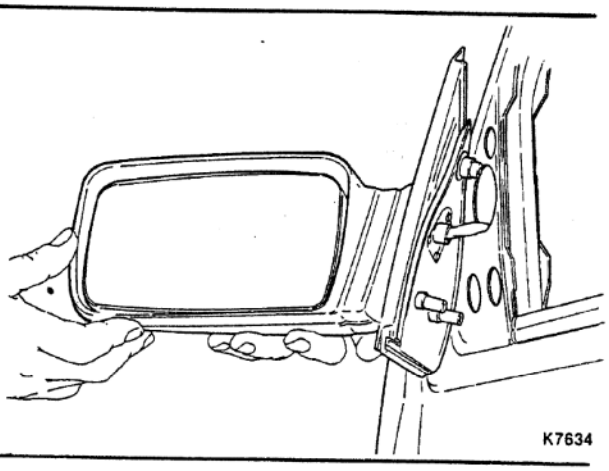
REMOVAL AND INSTALLATION (Continued)

POWER MIRROR ASSEMBLY (Continued)

6. Remove three screws holding mirror to door.



7. Remove mirror and shell assembly from door, guiding wiring and connector through hole in panel.



Installation

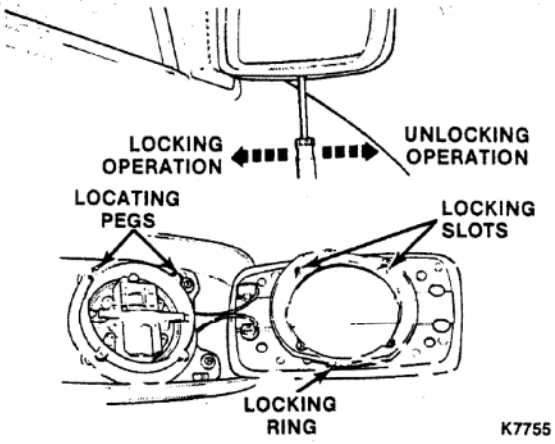
1. Guide mirror wiring through hole in door and reconnect wiring harness.
2. Position mirror to door and install three retaining screws.
3. Install mirror inner trim panel.
4. Reconnect mirror switch wiring connector.
5. Install door trim panel.
6. Reconnect battery ground cable.

REMOVAL AND INSTALLATION (Continued)

MIRROR GLASS

Removal

1. Insert thin screwdriver through hole in bottom of mirror assembly and release mirror locking lever while supporting glass.



Installation

1. Align locking ring on back face of glass with locking mechanism in mirror, and push glass into place. Use a thin screwdriver to actuate the locking lever to secure the glass.

SECTION 42-33 PIVOT TYPE QUARTER WINDOW

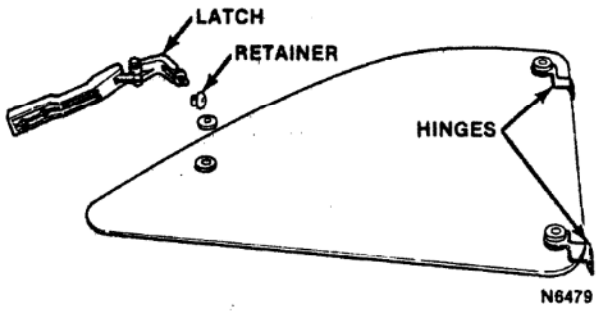
CONTENTS

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REMOVAL AND INSTALLATION

Glass 1

PIVOT TYPE QUARTER WINDOW

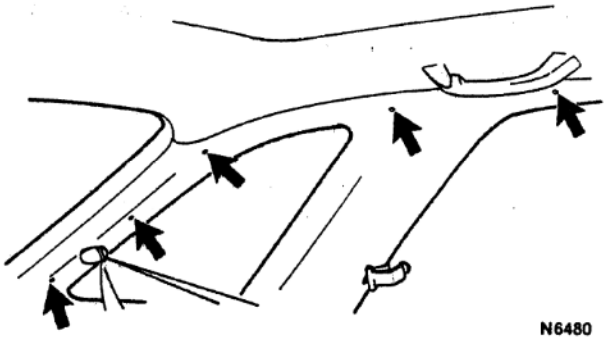


REMOVAL AND INSTALLATION

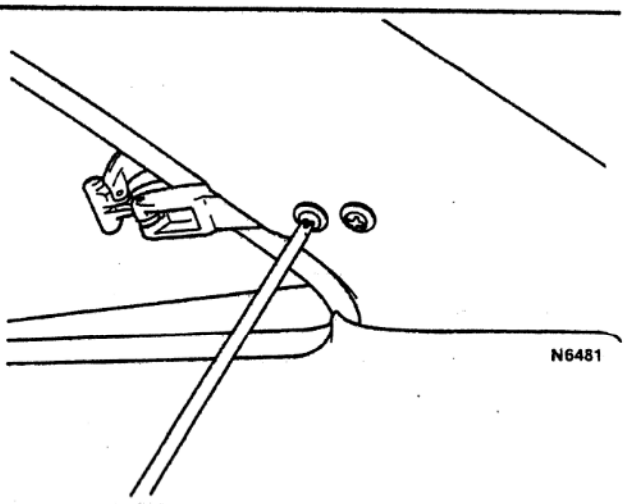
GLASS

Removal

1. Remove five screws from "C" pillar trim. Remove "C" pillar trim. Refer to Section 45-03.



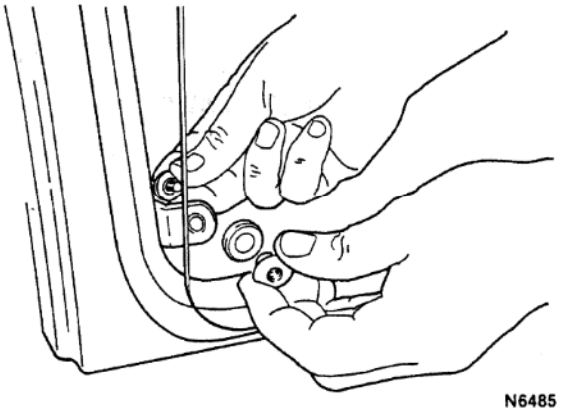
2. Remove two screws retaining window locking catch to body.



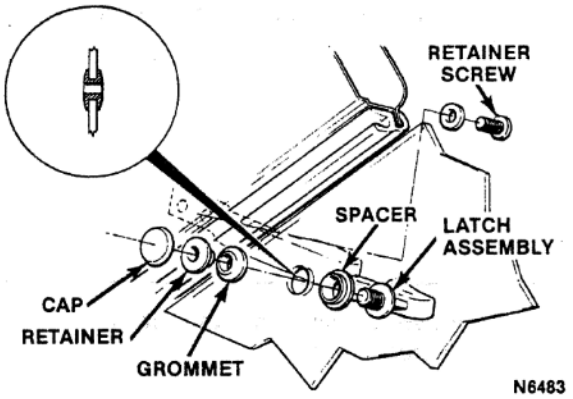
REMOVAL AND INSTALLATION (Continued)

GLASS (Continued)

3. Supporting the glass on both sides, remove two screw covers retaining hinges to glass. Detach assembly.



4. Detach cap and unscrew retainer securing latch to window. Remove latch assembly from window.



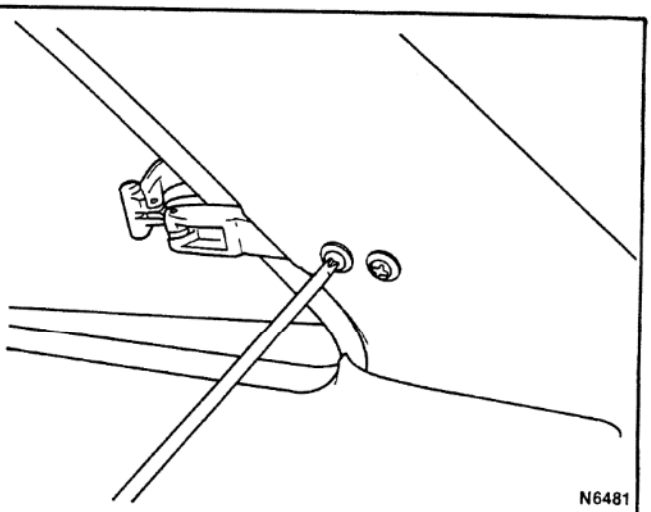
Installation

1. Install window locking catch assembly to window.
2. Install glass into body aperture. Reinstall hinges to glass.

REMOVAL AND INSTALLATION (Continued)

GLASS (Continued)

3. Install locking catch to body.



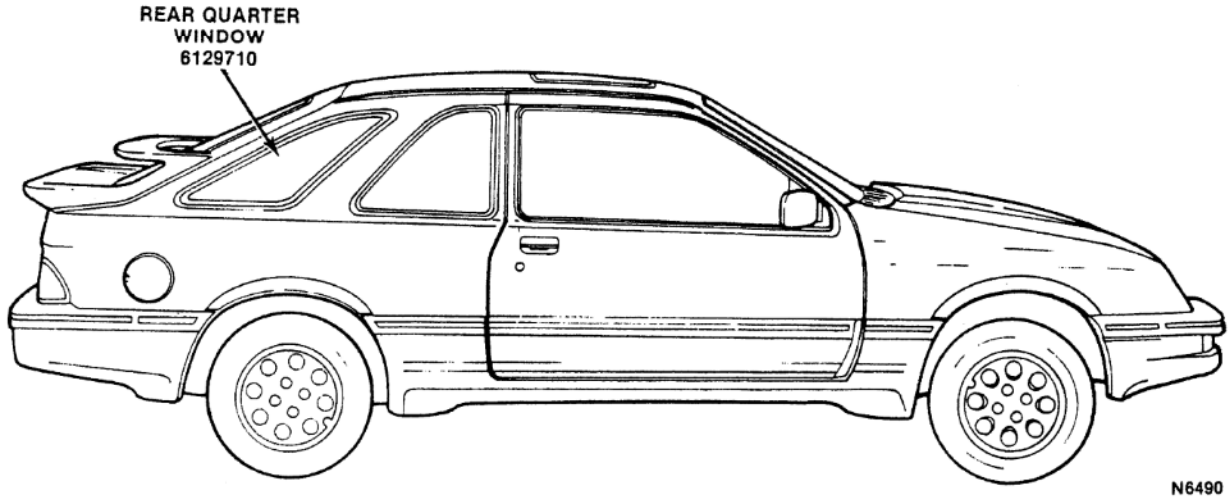
4. Reinstall "C" pillar trim. Refer to Section 45-03.

N6481

SECTION 42-38 REAR QUARTER WINDOW—STATIONARY

CONTENTS

	Page
DESCRIPTION	1
REMOVAL AND INSTALLATION	
Rear Quarter Window	2

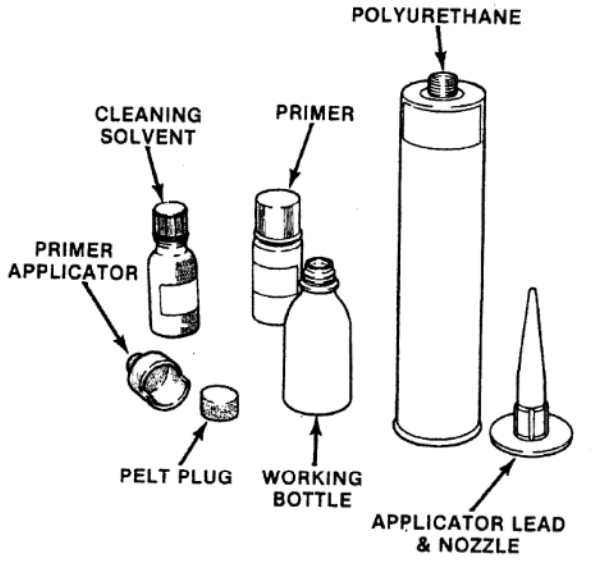


DESCRIPTION

The rear quarter window is direct glazed using the same method used for the windshield and liftgate glass. Also use the direct glazing kit EOAZ-19562A consisting of:

- Cartridge of polyurethane (PU) adhesive
- Applicator head for primer
- Applicator nozzle
- Working bottle for the primer
- Felt plug
- Glass primer
- Cleaning solvent
- Cutting wire.

In addition, a cartridge gun, two glazier suction cups, and a carpet cutting knife will be required.



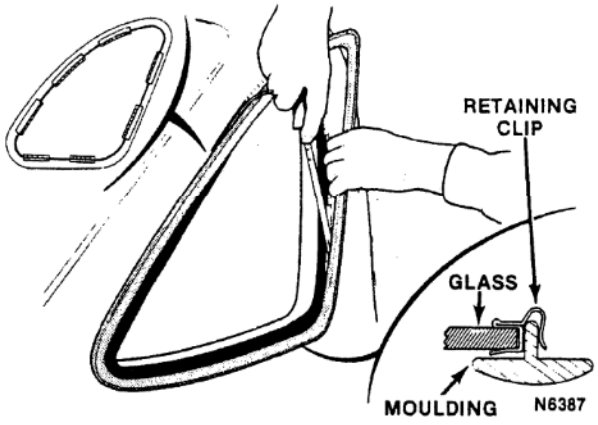
REMOVAL AND INSTALLATION

SPECIAL SERVICE TOOLS REQUIRED:
Sealant Knife D81P-42006-B

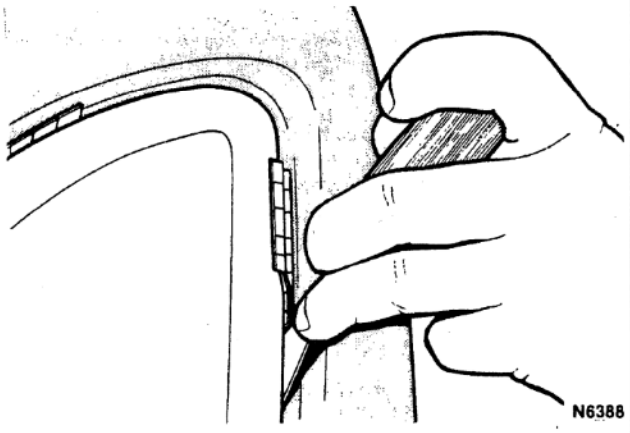
REAR QUARTER WINDOW

Removal

1. Remove the molding from the gap between the glass and window aperture.



2. Bend molding retaining clips away from glass.



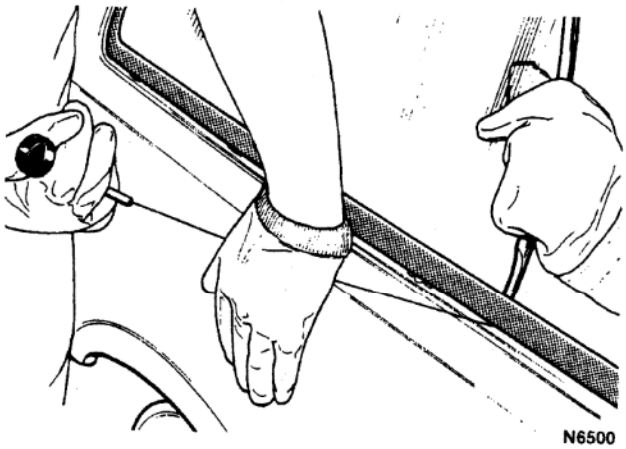
3. From inside the vehicle, remove the quarter window panel.
4. Remove the seat belt upper mount and "B" pillar trim.
5. Remove the "C" pillar trim.
6. Remove the glass between the adhesive and body flange using cutting wire:

REMOVAL AND INSTALLATION (Continued)

QUARTER WINDOW (Continued)

Cutting Wire

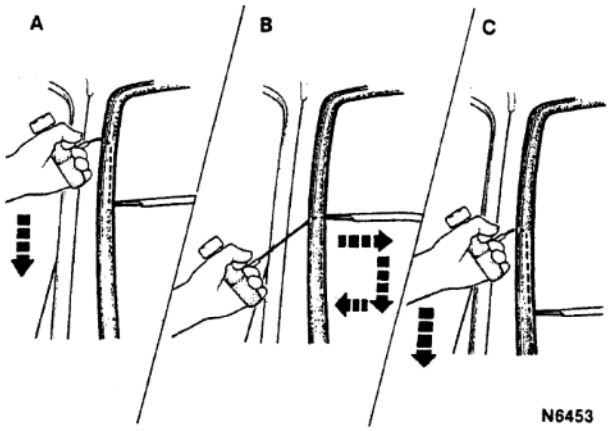
a. From inside of vehicle, using a pair of pliers, push wire through adhesive between glass and body flange.


N6500

b. From outside of vehicle, fit end of cutting wire into outer handle of tool.

NOTE: When pulling cutting wire, wear protective gloves and glasses.

c. Anchor inner end of tool into adhesive and pull tool around glass. Limit strokes to approximately 150 mm (6 in.). Use smaller strokes around corners. Take extra care when cutting beyond clips so as not to break the cutting wire.



N6453

LIMIT STROKES TO 150 MM (6 IN)

7. Remove glass from body aperture and rest on suction cups. Remove clips from aperture flange.

Installation

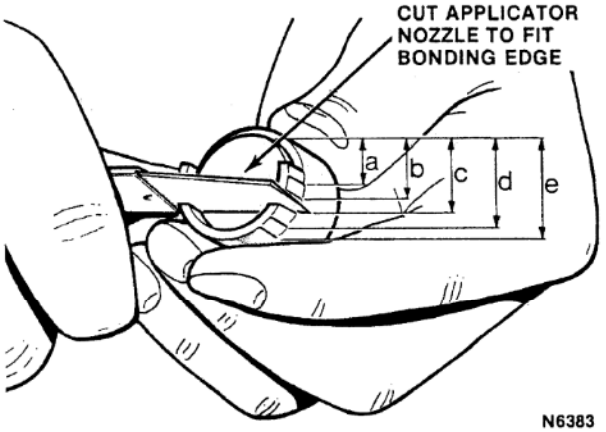
1. Remove the molding clips and discard. Trim off any excess PU adhesive taking care not to damage the paintwork.


N6501

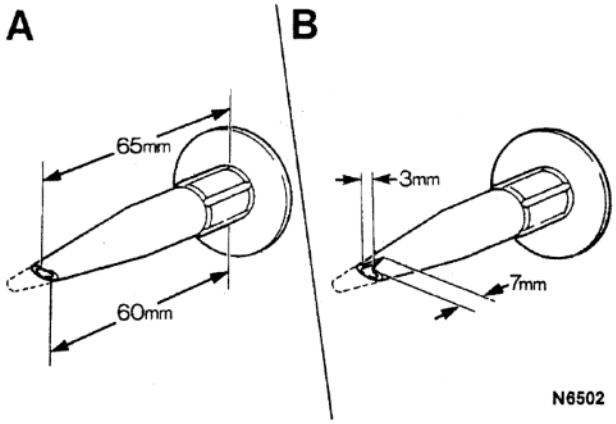
REMOVAL AND INSTALLATION (Continued)

QUARTER WINDOW (Continued)

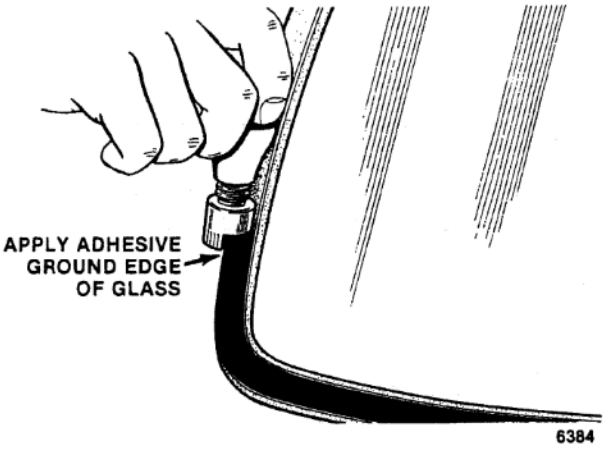
2. Clean the flange and edge of glass using an alcohol cleaner. Do not touch the cleaned areas or the bonding action of the new adhesive may be impaired. Make sure the flange and glass are dry before continuing. Fit new retaining clips to glass edges. Assemble molding to glass.
3. When fitting a new window, clean bonding edge of glass with cleaner. Cut the applicator nozzle (from kit) to suit bonding edge and apply primer (from kit) with applicator.



4. Cut the applicator with a "V" cut. Assemble the adhesive canister (from kit) and applicator nozzle into an applicator gun.



5. Apply a bead of adhesive around edge of glass.



6. Using a small paint brush, touch up any paint damage not covered by the PU adhesive with a suitable body primer. Make sure the primer does not come into contact with the PU adhesive.
7. Install the rear quarter window and molding assembly. Ensures an even fit around periphery of molding to body.
8. Install the rear parcel shelf bracket and panel.
9. Install the rear quarter trim panel.
10. Reinstall the "B" and "C" pillar trim and seat belt upper mount.
11. Clean off excess PU adhesive with a silicon or tar remover.

GROUP 43 STATIONARY GLASS

(70000)

SECTION 43-11 Stationary Glass

SUBJECT	PAGE
DESCRIPTION	43-11-1
REMOVAL AND INSTALLATION	
Windshield and/or Liftgate Glass	43-11-2

DESCRIPTION

The vehicle uses direct glazing on the windshield, liftgate window and fixed rear "sixth-light" windows. The advantage of direct glazing is that the glass is directly bonded to the window aperture flange. The body flange has a moulding attached which acts as a spacer to ensure the correct amount of adhesive between the glass and body flange. For cosmetic reasons, an exterior moulding is also used to cover the gap between glass and body edges. The adhesive ensures effective glass retention and sealing.

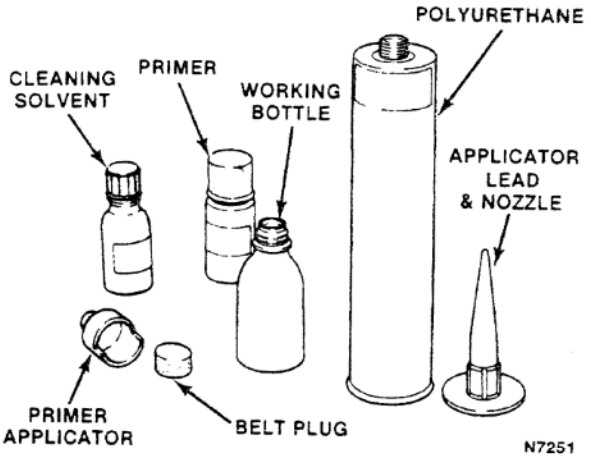
REMOVAL AND INSTALLATION

SPECIAL SERVICE TOOL REQUIRED:

When installing direct glazing windows, use a direct glazing kit E0AZ-19562A which includes:

- Cartridge of polyurethane adhesive
- Applicator nozzle
- Working bottle for primer
- Felt plug
- Glass primer
- Cleaning solvent
- Cutting wire.

In addition, a cartridge gun, two glazier suction cups and a carpet cutting knife will be required.

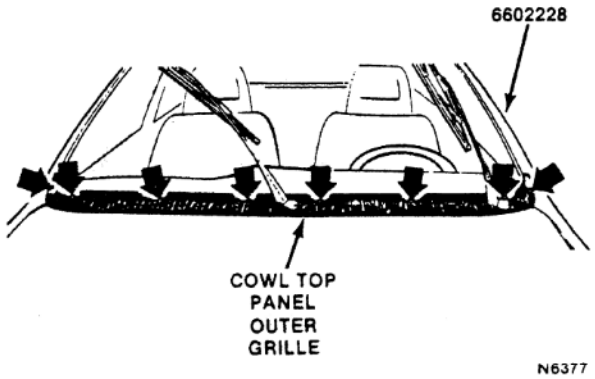


REMOVAL AND INSTALLATION (Continued)

Windshield and/or Liftgate Glass

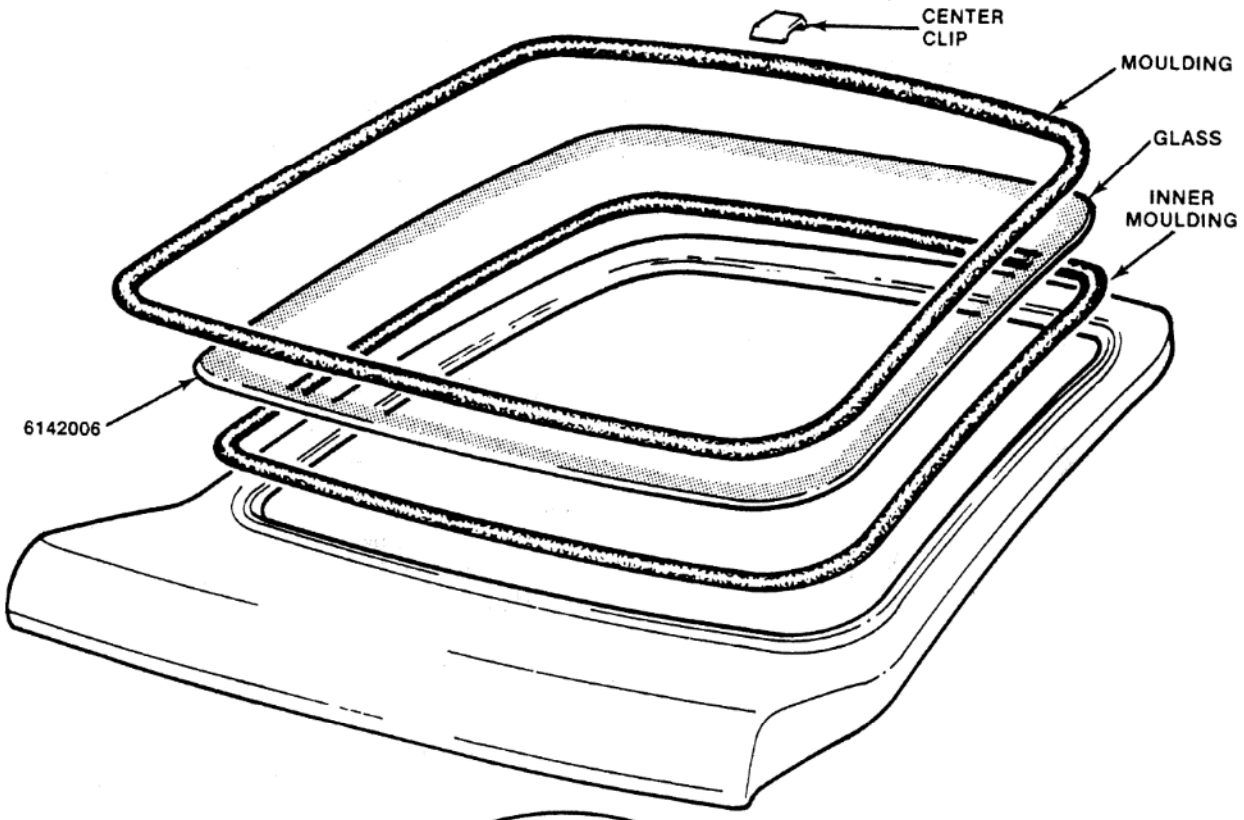
Removal

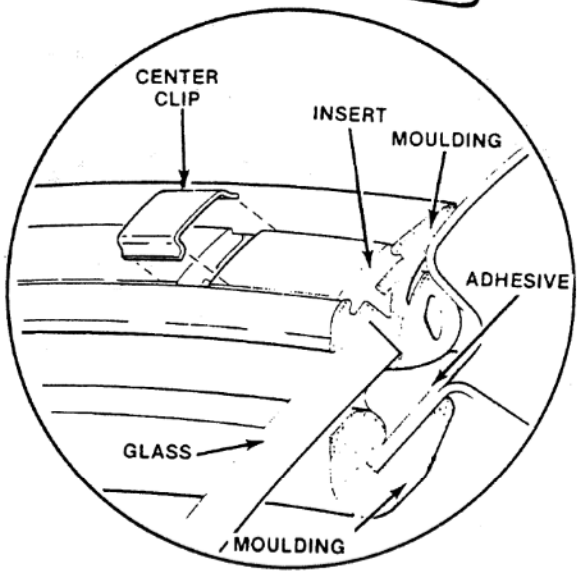
1. Place package of polyurethane (PU) adhesive in warm water 105-122°F (40-50°C). At the same time, make sure that the new moldings are in an ambient temperature of 68-77°F (20-25°C). These actions will facilitate subsequent adhesive application/molding installation.
2. **(Windshield Only).** Remove the cowl top panel outer grille assembly.



REMOVAL AND INSTALLATION (Continued)

3. Remove the center clip **(rear windows only)** and the insert from the molding. Then, withdraw the molding from the gap between the glass and the window aperture. Remove the two spacers **(windshield only)** from the cowl top panel.





N6378

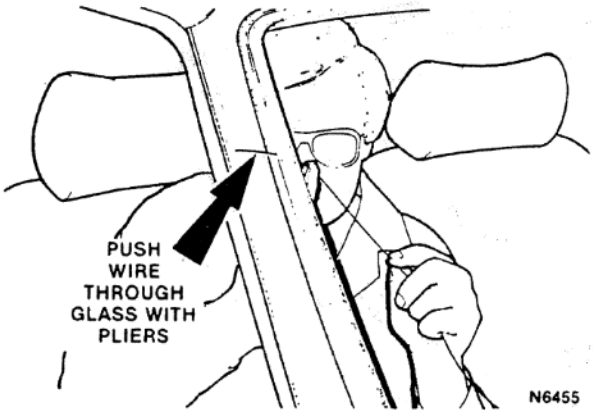
REMOVAL AND INSTALLATION (Continued)

4. Remove "A"-pillar trim panels **(windshield only).**
5. Cut the adhesive bond between the glass and body flange using cutting wire as follows:

Cutting Wire

NOTE: When pulling cutting wire, wear protective gloves and glasses.

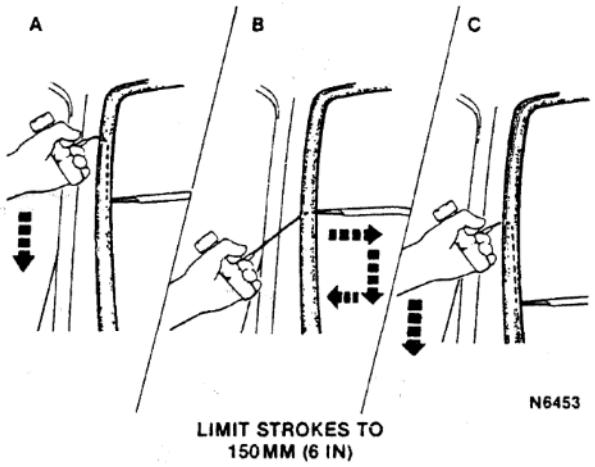
a. From inside of vehicle, using a pair of pliers, push wire through adhesive between glass and body flange.



b. From outside of vehicle, fit end of cutting wire into outer handle of tool.

c. While one technician anchors the lever end of the tool into the inner rubber moulding, a second technician should pull the "T" handle. Use long cutting strokes up to 500mm (20 in.) along the straight sections of the windshield as this will reduce the risk of wire breaking. The technician should use his free hand to hold the cutting wire as flat to the surface of the glass as possible. Shorter strokes 10-20mm (0.4-0.8 in.) should be used at the corners to avoid breaking the glass.

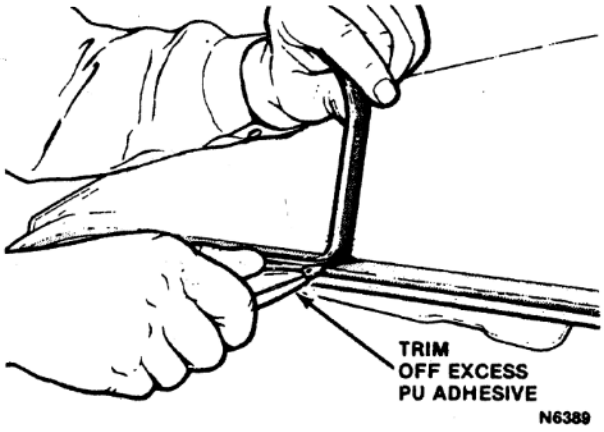
6. Use suction cups to lift out the glass. Place the external surface of the glass face down on a suitably protected surface.



7. From outside the vehicle, carefully remove the inner molding and discard.

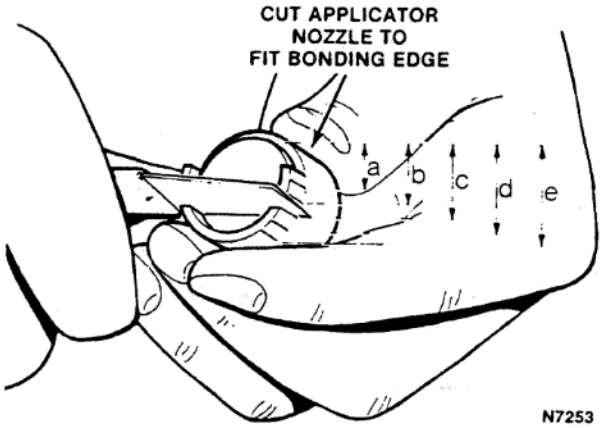
Installation

1. Carefully cut away the remaining PU adhesive from the body aperture. Take care to avoid damaging the paintwork. Also, remove PU remnants from edge of glass. The surfaces must be even so the new moldings can be fitted satisfactorily.

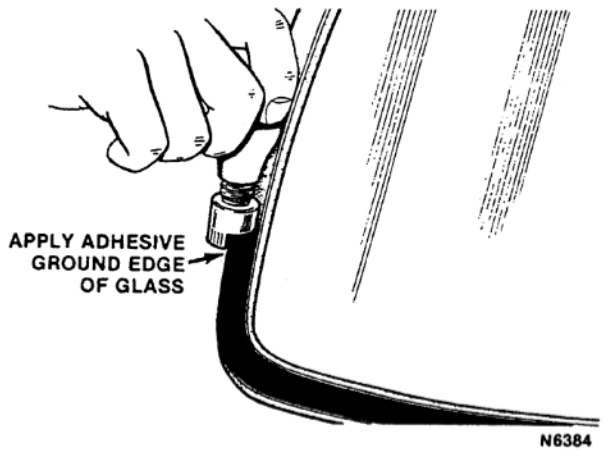


REMOVAL AND INSTALLATION (Continued)

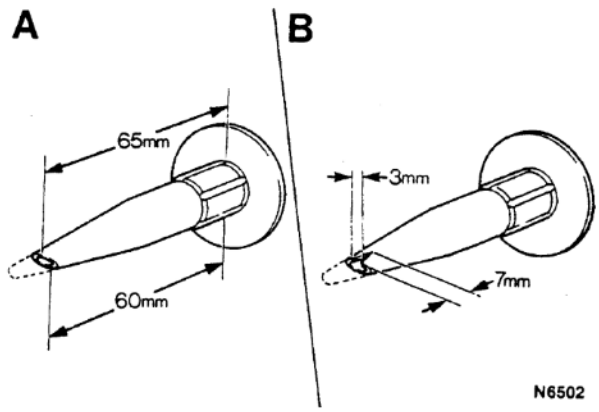
2. Clean the flange and edge of glass with alcohol. Do not touch the cleaned areas or the bonding action of the new adhesive may be impaired. Ensure the flange and glass are dry before continuing.
3. Fit a new inner moulding on the aperture flange by pressing the moulding onto the aperture flange starting with the corners. The moulding should be pressed down firmly, especially in corners, to ensure correct seating.
4. When the moulding has been fitted all the way around the aperture, the surplus moulding should be cut off and pressed down firmly to ensure a tight fit between moulding ends.



5. APPLICABLE ONLY WHEN INSTALLING NEW GLASS
   a. Apply cleaning solvent to the edge of the glass using a tissue or lint-free cloth and wipe off with a clean cloth.
   b. Trim the applicator to size.
   c. Shake the glass primer for at least 45 seconds, transfer to applicator bottle and apply along edge of glass. Allow to dry, for a minimum of 10 minutes.

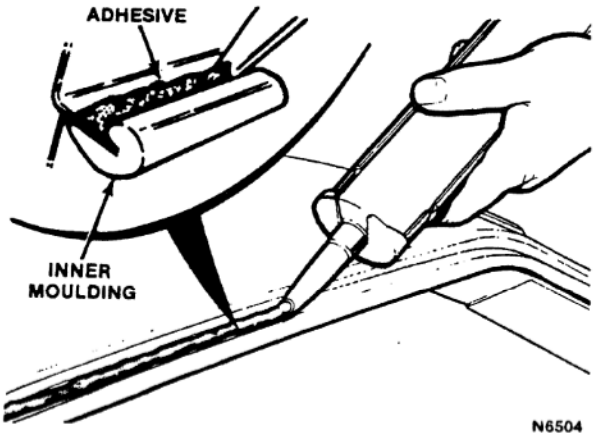


6. If the new moulding has a lip, tear the rubber lip off and fit the moulding around the glass. Make sure the moulding is mounted evenly. Current production windshields have a moulding locating mark on the black ceramic band at the bottom of the right- and left-hand sides to indicate moulding start and finish points. The moulding should be at room temperature 68-77°F (20-25°C).
7. Cut the applicator nozzle with a "V" cut.



8. Puncture the adhesive canister. Assemble the applicator nozzle and canister into an applicator gun. The PU adhesive must be used within two hours of the seal being broken. Before applying adhesive to the moulding, test bead application on a piece of wastepaper.
9. Pressing the applicator nozzle firmly against the inner moulding, apply a bead of adhesive around the aperture flange. The bead profile should be approximately 5mm higher than the inner moulding.

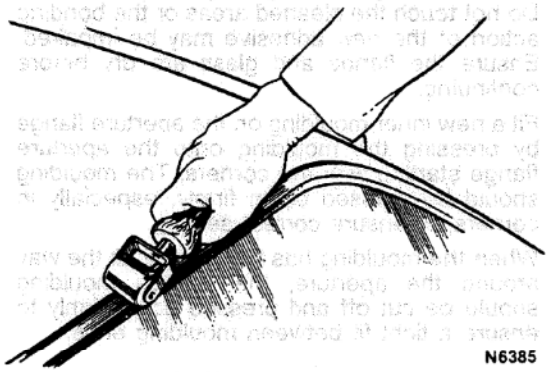
   NOTE: Max. open time for PU-Bead is 10 minutes.



REMOVAL AND INSTALLATION (Continued)

NOTE: Take care to obtain a smooth continuous bead. It will be more difficult to fill in patches to the correct height and profile afterwards.

10. Using a small paint brush, carefully repair any paint damage not covered by the PU adhesive bead with suitable body primer. Make sure the primer does not come into contact with the PU adhesive.
11. Fit new spacers in original positions on the cowl top panel.
12. Lift the glass and moulding assembly using suction cups and lower into the aperture ensuring the moulding to body gap is even.
13. Press the glass into contact with the inner moulding, starting with even pressure at the center and working out to the "A" pillars.
14. Smooth the adhesive surface at the bottom of the windshield.
15. Push the moulding into the position using a roller.



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16. Reinstall the "A" pillar trims (windshield only).
17. Install cowl top panel outer grille assembly (windshield only).
18. Clean off excessive PU adhesive over the entire working area using silicon or tar remover.

WARNING: THE VEHICLE MUST BE LEFT PARKED IN THE SHOP FOR TWO HOURS AFTER THE GLASS HAS BEEN FITTED. THE DOOR WINDOWS SHOULD BE LEFT OPEN DURING THIS TIME SO THAT NO PRESSURE CAN BUILD UP INSIDE THE VEHICLE IF THE DOORS ARE INADVERTENTLY CLOSED.

DOORS, HOOD, LUGGAGE BOX, AND LIFTGATE

GROUP 44

TITLE SECTION	PAGE NO.	TITLE SECTION	PAGE NO.

DOOR, HINGE, WEATHERSTRIP, LATCH AND LOCK 44-06

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- Door Lock Cylinder 2
- Door Latch 2
- Central Locking 2

ADJUSTMENTS 3

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- Door Hinge 5
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- Door Opening Weatherstrip 8
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HOOD, HINGE AND LATCH 44-21

DESCRIPTION 2

ADJUSTMENTS
- Hood Alignment 2
- Hood Bumpers 2
- Striker 3
- Auxiliary Hood Catch 3

REMOVAL AND INSTALLATION
- Hood Latch Control Cable 3
- Hood 5
- Hood Hinge 6
- Hood Support Rod 6
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- Striker 7

LIFTGATE DOOR, LATCH, LOCK AND WEATHERSTRIP 44-41

DESCRIPTION 1

ADJUSTMENTS
- Liftgate Up-and-Down, Side-to-Side 2
- Liftgate Latch Striker Plate 2

REMOVAL AND INSTALLATION
- Liftgate Latch and Lock Barrel 2
- Remote Liftgate Release Solenoid 3
- Liftgate Central Locking Solenoid 3
- Cylinder 4
- Liftgate Assembly 4
- Liftgate Weatherstrip 5

SECTION 44-06 DOOR, HINGE, WEATHERSTRIP, LATCH AND LOCK

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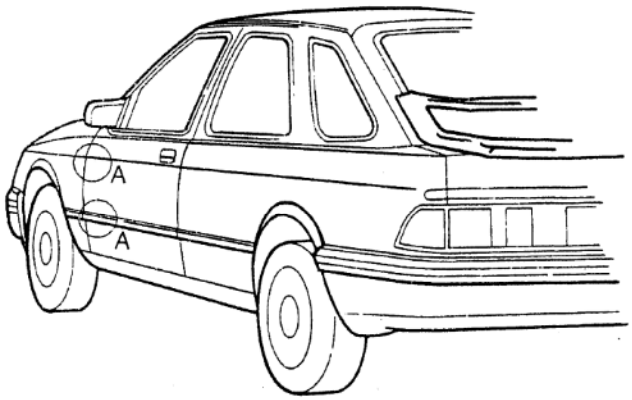
DESCRIPTION	Page
Door Hinges	1
Door Lock Cylinder	2
Door Latch	2
Central Locking	2
ADJUSTMENTS	3

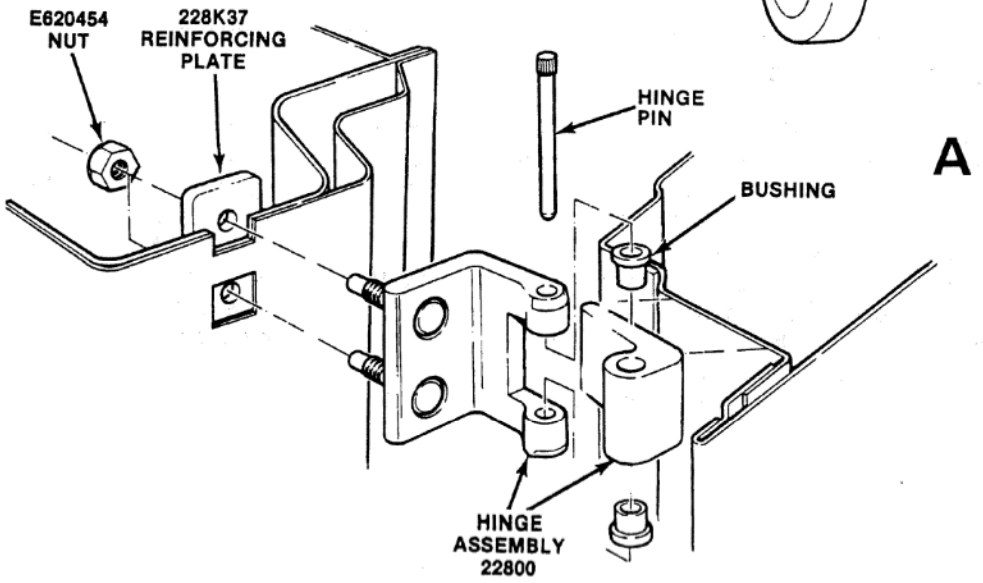
REMOVAL AND INSTALLATION	Page
Side Doors	3
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Door Latch Remote Control	7
Door Opening Weatherstrip	8
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Central Locking Solenoid	13

DESCRIPTION

DOOR HINGES

The vehicle door hinges pivot around solid hinge pins which cannot be removed in service. The hinges are secured to the body with two nuts and bolts and are welded to the door.





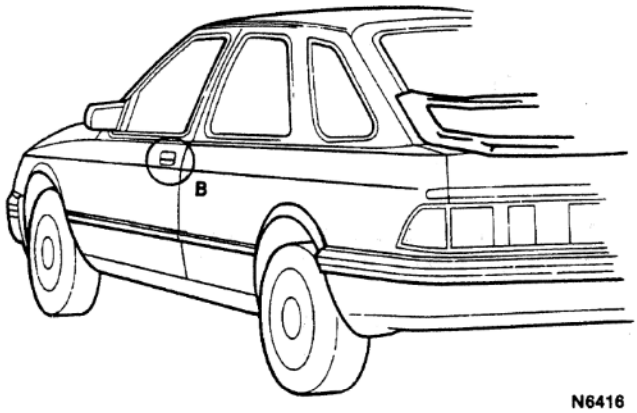
DESCRIPTION (Continued)

DOOR LOCK CYLINDER

The vehicle door lock cylinder is a ten-tumbler "TX" type design.

DOOR LATCH

The door latch is of a conventional design. To remove the door latch assembly, first disconnect the DOOR AJAR warning switch.



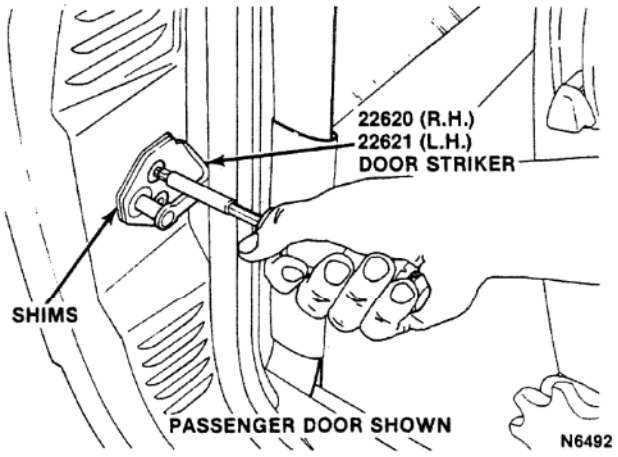
N6416

CENTRAL LOCKING SYSTEM

The central locking system allows the doors and liftgate to be locked by the driver upon operation of the driver's door lock. This is done either by turning the key in the lock or by operation of the door lock lever on the driver's door. Because the driver's door lock is operated by the key or door lock lever, a solenoid is not fitted to the driver's door. The driver's door lock is connected to a ground switch by means of an additional lug on the lock and a moveable arm on the switch. The two output terminals on the switch are connected to the input side of the central locking pulse relay. The pulse relay outlet terminals are connected with each individual lock solenoid. When unlocking or locking the driver's door, one of the two terminals on the switch is grounded. This triggers the relay which releases a short current pulse to each lock solenoid.

ADJUSTMENTS

The door striker can be adjusted in and out by adding or deleting shims and then tightening the striker. The front doors can be adjusted up and down and fore and aft. The doors cannot be adjusted in and out due to the fact that the side door hinge system is a weld-on door/bolt on-body design.



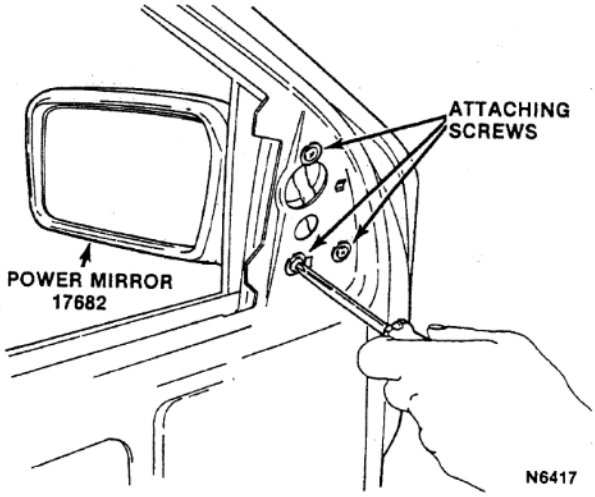
To adjust the side doors up or down, remove the cowl side trim panel and loosen the adjusting bolts and adjust the door up or down as necessary.

REMOVAL AND INSTALLATION

SIDE DOORS

Removal

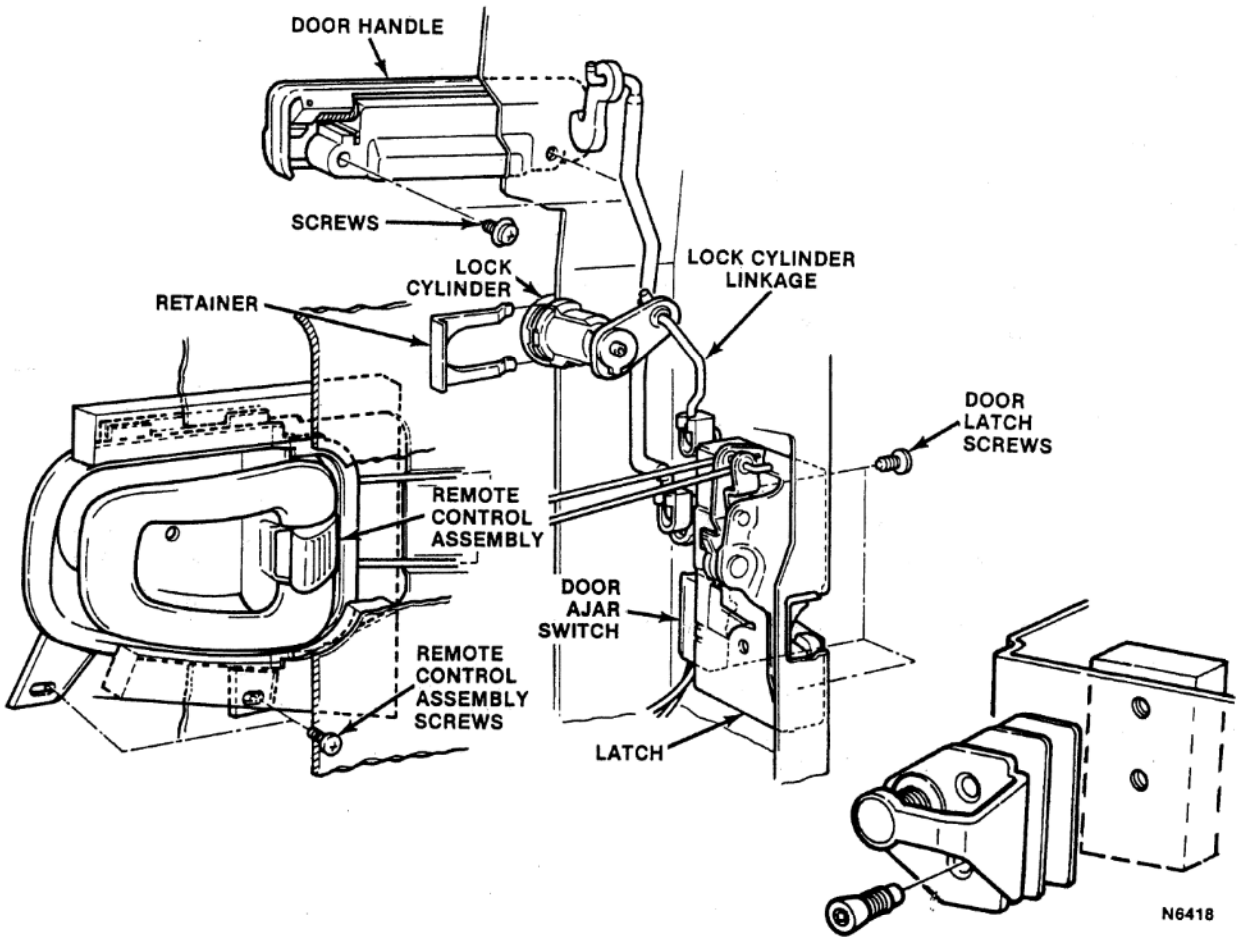
1. Remove the bezel and door grab handle.
2. Remove the window regulator handle (if equipped).
3. Remove the electric mirror operating switch (driver door only).
4. Remove door trim panel and map pocket.
5. Unclip the door mirror trim, remove attaching screws and detach door mirror.



REMOVAL AND INSTALLATION (Continued)

SIDE DOORS (Continued)

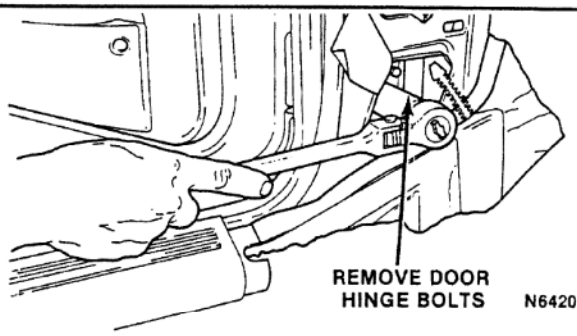
6. Disconnect all electrical connectors.
7. Disconnect and remove the external door handle (two screws) from the latch.
8. Disconnect lock cylinder linkage from latch and remove retainer and lock cylinder.
9. Disconnect the door ajar switch and then . . .
10. Disconnect remote handle assembly (two screws) and four rod panel retaining clips.
11. Remove door latch (three screws) together with remote control assembly.



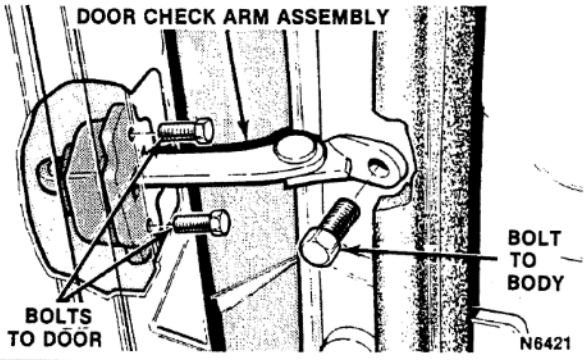
REMOVAL AND INSTALLATION (Continued)

SIDE DOORS (Continued)

12. Remove cowl side trim and dash lower insulating panel. Remove lower safety covering.
13. Remove nuts and reinforcing plates from door hinge bolts and remove door.



14. Remove one bolt retaining door check arm to body and two bolts retaining check arm to door. Remove door check arm.



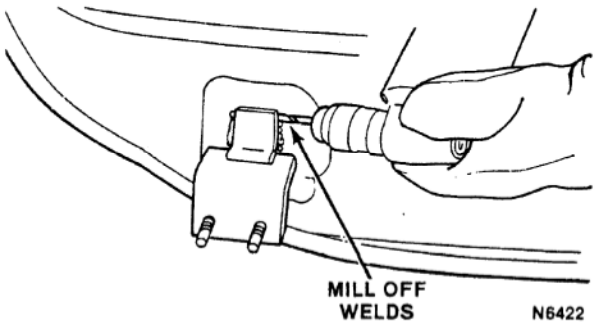
Installation

1. Position door to upper and lower hinges and install retaining plates and nuts. Visually check door alignment before final torque is applied to nuts.
2. Position door latch to body and install retaining bolt.
3. Visually check the door alignment with adjacent panels. If adjustment is needed, loosen door latch striker and loosen the hinge nuts. Adjust door.
4. Connect electrical connectors.
5. Install lower safety covering, dash lower insulating panel and cowl side trim.
6. Install lock cylinder and external door handle.
7. Install door ajar switch, latch and remote control assembly.
8. Attach door mirrors and trim. Reconnect electrical connector for outside mirror. Install door trim panel and map pocket.
9. Install power mirror switch.
10. Install remote control handle and bezel.
11. Install door grab handle, bezel, and window regulator handle (if equipped).

DOOR HINGE

Removal

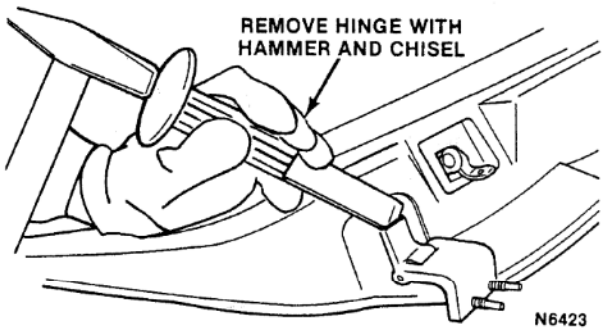
1. Using a suitable milling cutter, mill off welds at junction of door panel and hinge.



REMOVAL AND INSTALLATION (Continued)

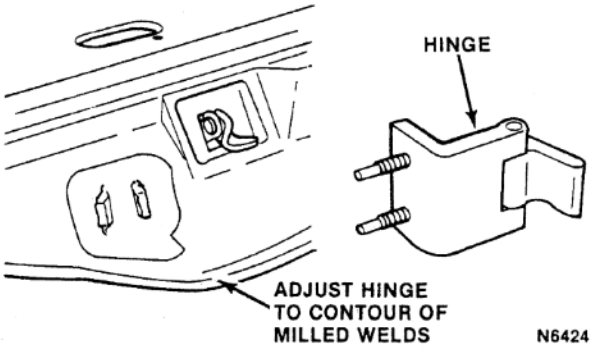
DOOR HINGE (Continued)

2. Remove hinge from door panel with hammer and chisel.



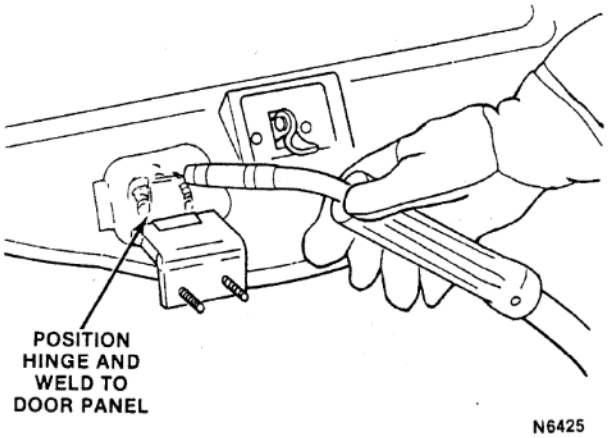
Installation

1. Adjust new hinge to the contour of the milled welds on the door panel.



2. Position hinge and weld to door panel.

3. Prime and paint area around door panel and hinge.

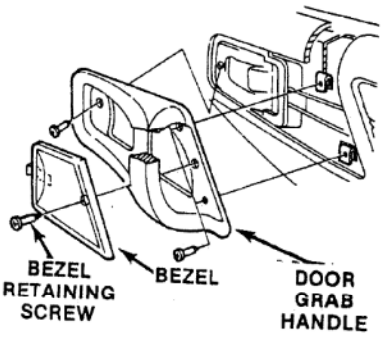


REMOVAL AND INSTALLATION (Continued)

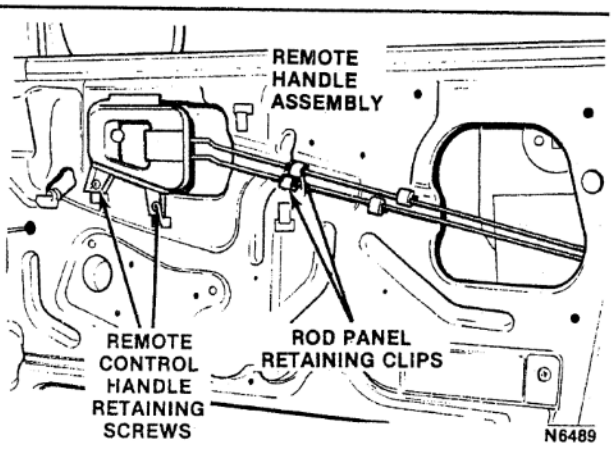
DOOR LATCH REMOTE CONTROL

Removal

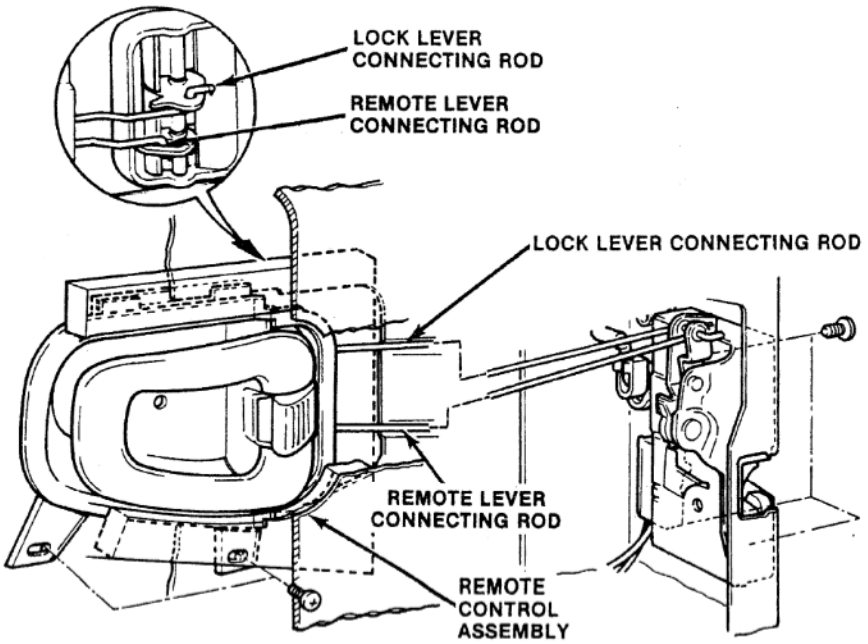
1. Remove the screw attaching bezel. Slide the bezel forward to remove.
2. Remove the screws attaching door grab handle and then remove the grab handle by sliding it over the remote handle assembly.



3. Remove window regulator handle cover (if equipped) and attaching screw. Remove handle with bezel.
4. Remove door trim panel and map pocket.
5. Remove two screws attaching remote control handle. Slide remote control downward to disengage it from its retaining lug.



6. Disconnect remote lever operating rod and lock lever connecting rod. Remove remote control assembly from door.



REMOVAL AND INSTALLATION (Continued)

DOOR LATCH REMOTE CONTROL (Continued)

Installation

1. Insert remote control assembly into door and install connecting rods to lock lever and handle lever. Position handle in aperture and slide up to engage retaining lug.
2. Align retaining holes in assembly with holes in door so that lock lever movement is not restricted. Install two attaching screws.
3. Check that the door latch release function is correct. When the latch mechanism is fully engaged, it should **not** be in the partial release position.
4. Install watershield and door trim panel.
5. Replace door grab handle and bezel.
6. Replace regulator handle.

DOOR OPENING WEATHERSTRIP

Removal

Pull weatherstrip off of weld flange around door opening.

Installation

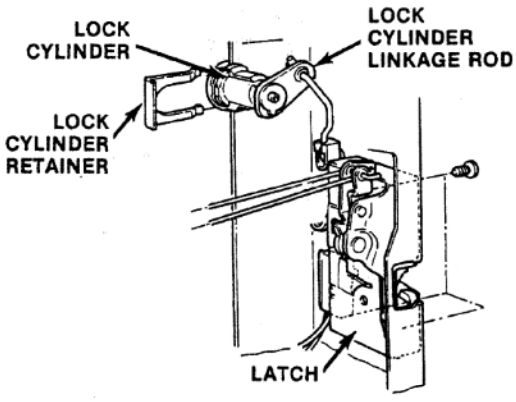
Use a rubber hammer to gently tap the weatherstrip in place over the steel carriers.

CAUTION: Do not use a metal hammer to tap the weatherstrip in place. The steel reinforced carrier could be damaged which may then cause water leaks.

DOOR LOCK CYLINDER

Removal

1. Remove trim panel. Position watershield away from the access hole.
2. Disconnect the lock cylinder linkage rod at the latch.
3. Remove door lock cylinder retainer. Remove lock cylinder from door.



NOTE: All lock cylinders should be operated by one key; therefore, lock cylinders should be replaced as a set or serviced to maintain a one key system.

REMOVAL AND INSTALLATION (Continued)

DOOR LOCK CYLINDER (Continued)

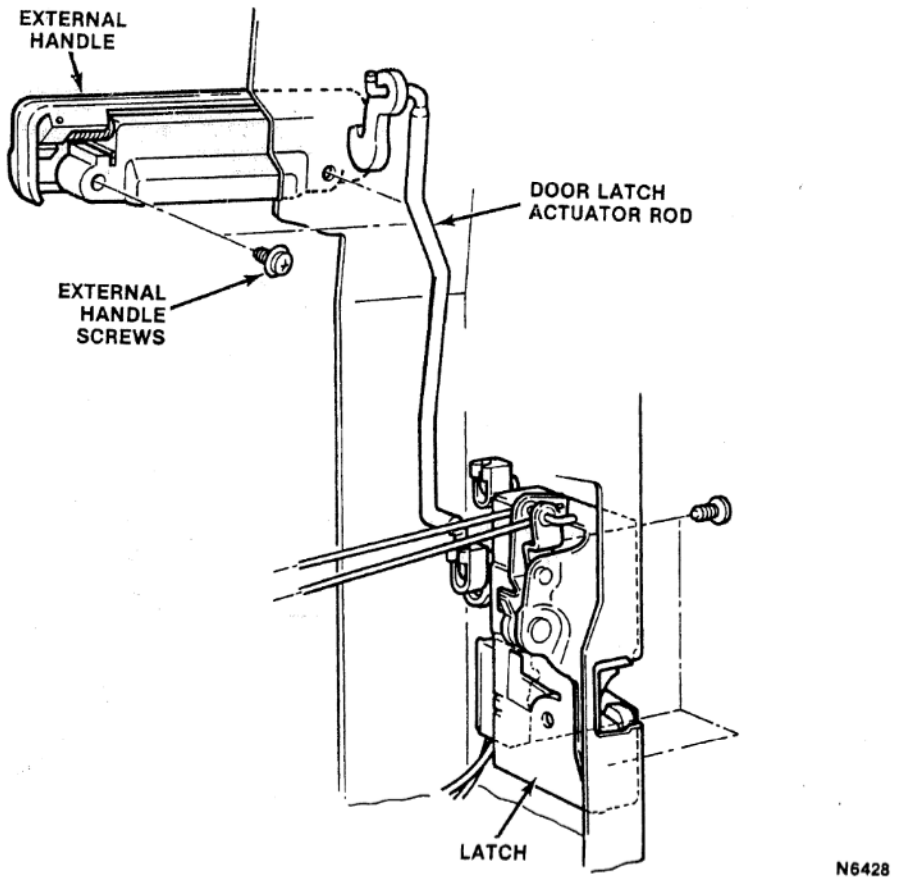
Installation

1. Transfer lock cylinder linkage rod and gasket to new lock cylinder.
2. Position lock cylinder in the door. Install lock cylinder retainer.
3. Connect the linkage rod at the latch and secure to retention clip.
4. Carefully position the watershield to the inner panel and install the trim panel.

DOOR OUTSIDE HANDLE

Removal

1. Remove door trim panel and watershield.
2. Disconnect door latch actuator rod from latch.
3. Remove external handle.
4. To install, reverse steps 1 through 3.

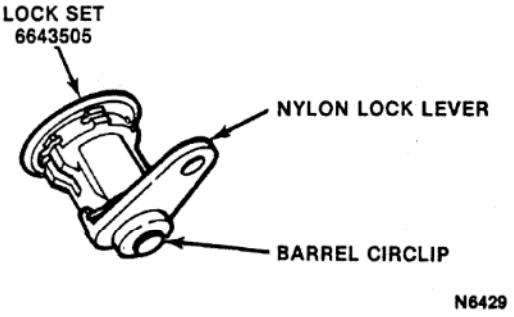


REMOVAL AND INSTALLATION (Continued)

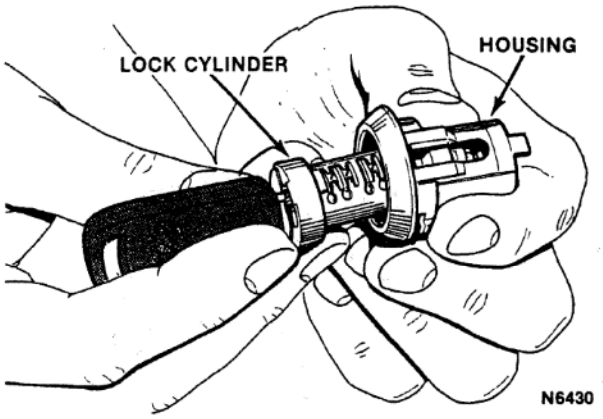
DOOR LOCK CYLINDER TUMBLERS

Removal

1. Remove door lock cylinder.
2. Unclip barrel circlip and detach nylon lock lever.
3. Remove lock cylinder return spring.
4. Pry off the lock shutter cap with a pair of pliers and discard the cap.

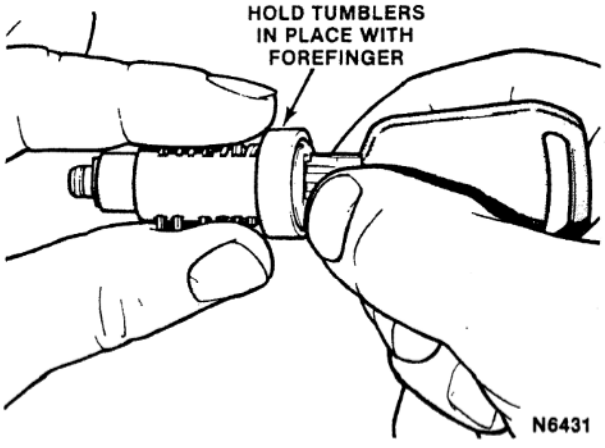


5. Insert key into lock and pull lock cylinder from its housing. Check that with the key inserted, all ten tumblers are flush with the diameter of the key barrel. Replace tumbler if it protrudes or sticks.



6. Carefully remove key from cylinder and remove shutter plate.

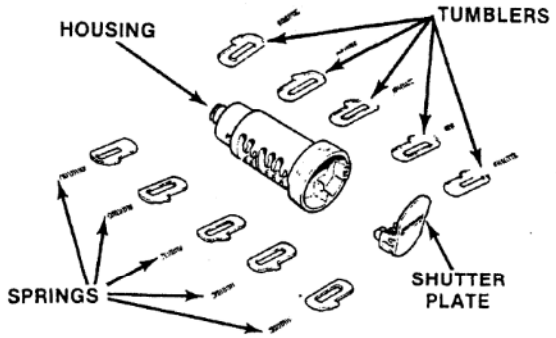
   NOTE: When removing key from cylinder, use your forefinger and thumb to hold tumblers in position.



REMOVAL AND INSTALLATION (Continued)

DOOR LOCK CYLINDER TUMBLERS REMOVAL (Continued)

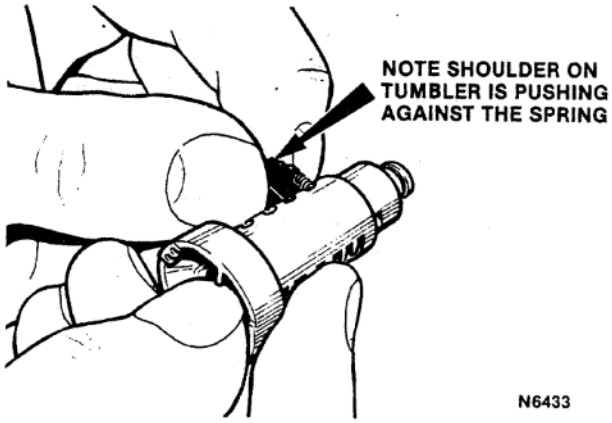
7. Carefully remove tumblers and springs from the housing keeping each tumbler in careful order.
8. Clean and inspect tumblers, tumble springs and shutter plate for damage. Replace as necessary.



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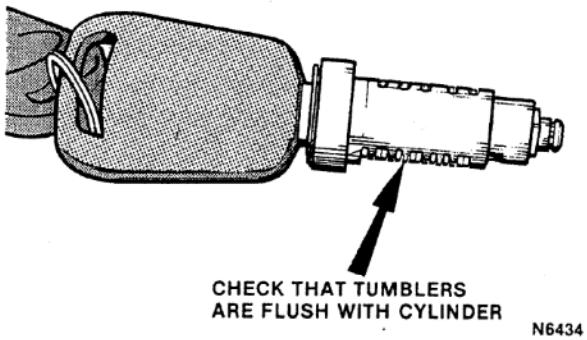
Installation

1. Lightly lubricate lock cylinder. Install springs and then slide tumblers into position so that the shoulder on the tumbler pushes against the spring.



N6433

2. Slide key into cylinder and check that all the tumblers are flush with the cylinder as shown.

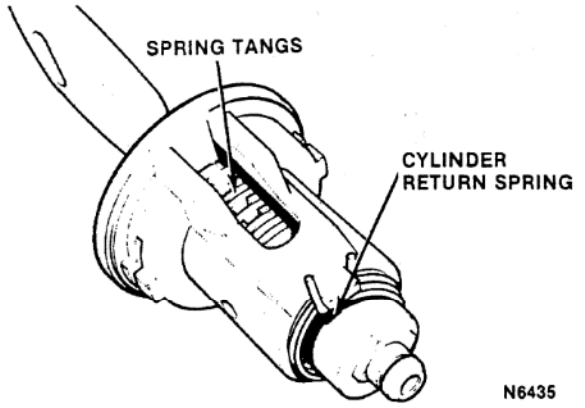


N6434

REMOVAL AND INSTALLATION (Continued)

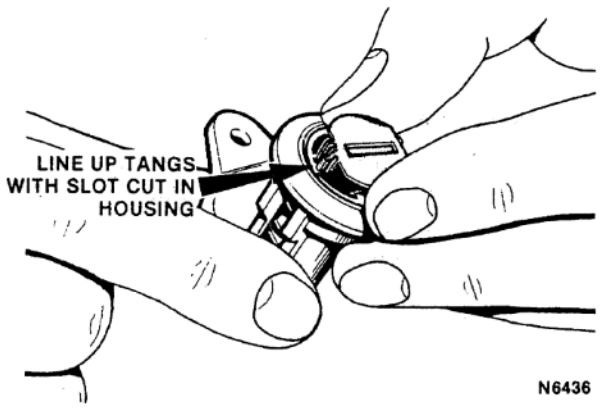
DOOR LOCK CYLINDER TUMBLERS INSTALLATION (Continued)

3. Slide cylinder into housing. Turn cylinder so that tumblers are visible along slot cut into housing.
4. Install cylinder return spring making sure that the spring tangs are properly positioned.

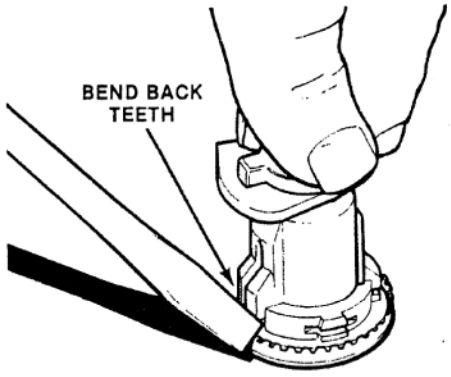


5. Position nylon lock lever ensuring the tag on the lever is between the tangs of the spring. Install endclip and check to see if the plate and lever rotate. Withdraw key.
6. Apply a generous coating of grease in the shutter plate opening. (Ensure that the water drainage slot in housing is not blocked with grease.) Insert a new shutter plate.

   NOTE: The shutter plate will only fit one way. Make sure the tags on the shutter line up with the slots cut in the housing.



7. Apply a generous coating of grease to the inside face of the shutter cap and install a new service cap on the lock cylinder.
8. Bend back serrated teeth to secure cap.
9. Wipe off any excess grease expelled from lock cap during assembly.
10. Check the operation of the lock to make sure the key can be inserted and withdrawn without any tendency to bind.

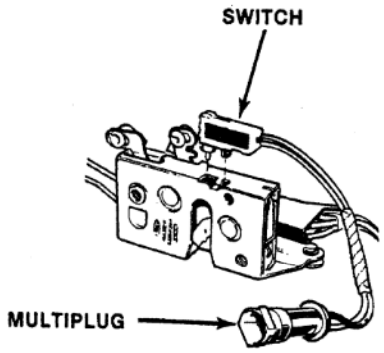


REMOVAL AND INSTALLATION (Continued)

DOOR AJAR SWITCH

Removal and Installation

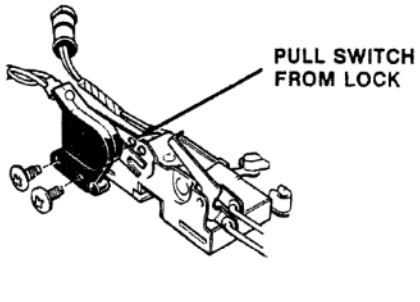
1. Remove door trim panel.
2. Pull switch to remove from door latch and disconnect multiplug.
3. To install, reverse steps 1 and 2.



CENTRAL LOCKING SWITCH

Removal

1. Remove door trim panel.
2. Remove door lock cylinder as detailed in this section.
3. Disconnect central locking multiplug at base of door.
4. Remove central locking switch from lock by removing two screws and pulling switch from lock.



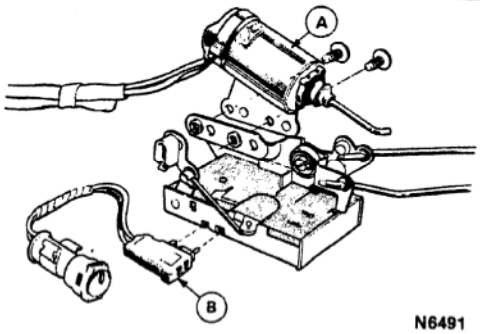
Installation

1. Install switch to lock and retain with two screws. Ensure slotted cut-out in switch arm is engaged with lock arm.
2. Install lock to door and reconnect multiplug at base of door.
3. Test operation of switch.

CENTRAL LOCKING SOLENOID

Removal

1. Remove door trim panel.
2. Remove door lock as detailed in this section.
3. Remove two phillips head screws retaining solenoid to lock. Disconnect multiplug and remove solenoid.



REMOVAL AND INSTALLATION (Continued)

CENTRAL LOCKING SOLENOID (Continued)

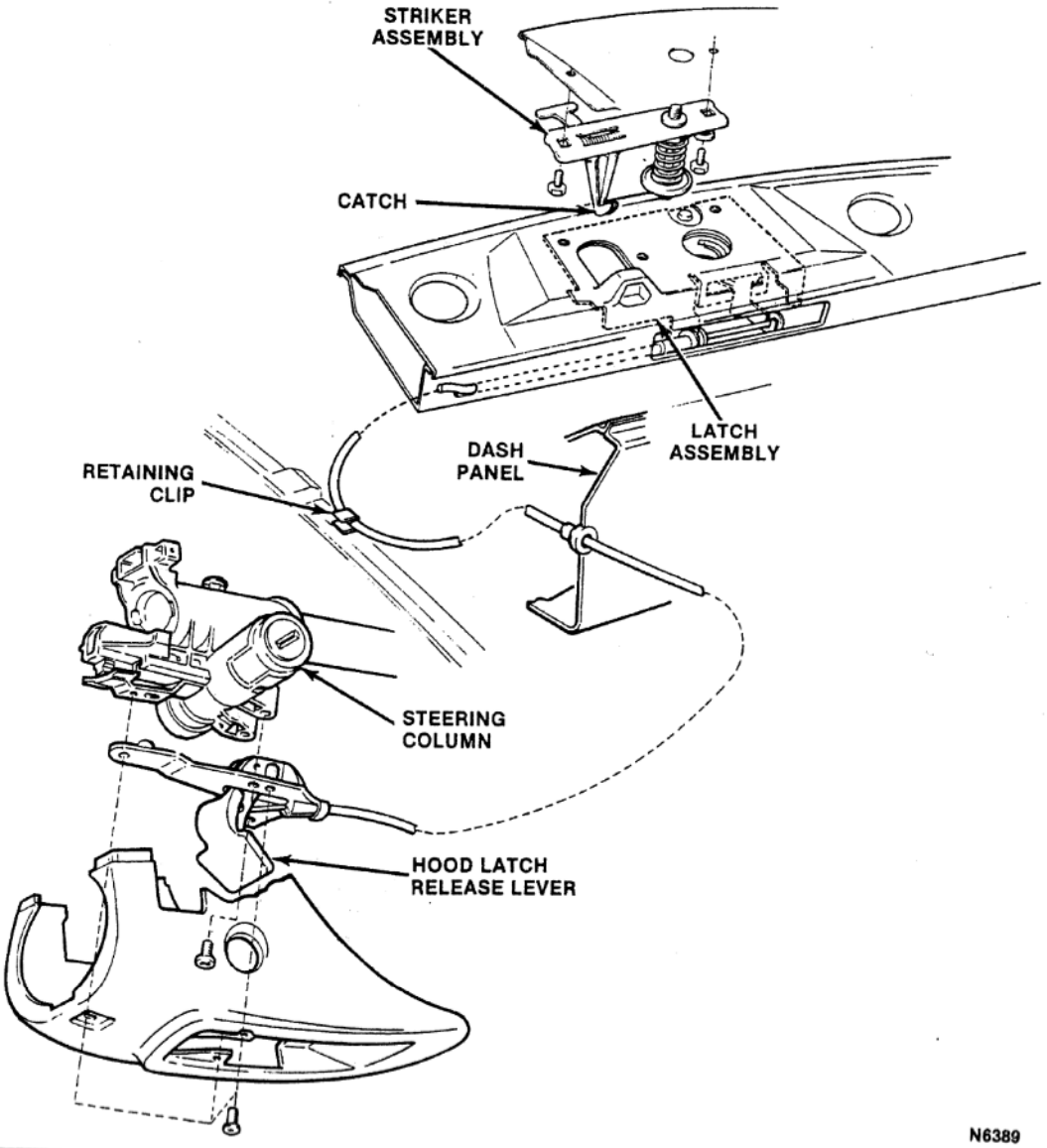
Installation

1. Install solenoid to door lock and retain with two phillips head screws.
2. Reconnect multiplug and reinstall door lock as detailed in this section.
3. Check operation of solenoid.

SECTION 44-21 HOOD, HINGE AND LATCH

CONTENTS

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DESCRIPTION

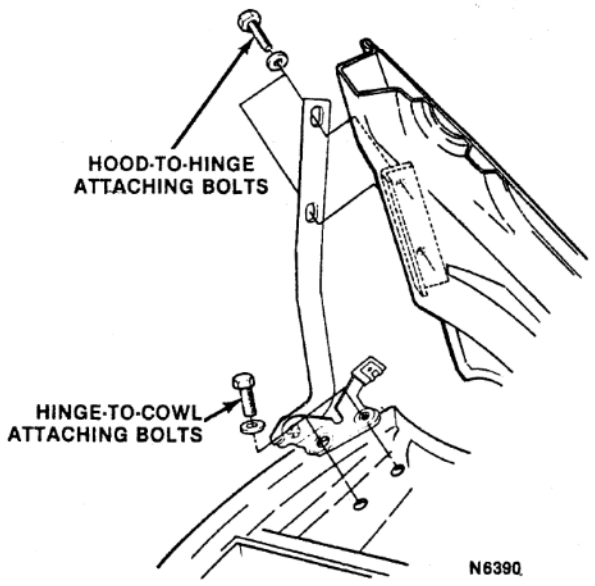
The hood release lever is fixed to the underside of the steering column. The cable runs through the dash panel and around the engine compartment to the hood lock assembly. The hood can be supported in the full-up position by propping the hood open with the hood support rod.

ADJUSTMENTS

HOOD ALIGNMENT

1. The hood can be adjusted fore-and-aft or the rear corners raised or lowered by loosening the hood-to-hinge attaching bolts and repositioning the hood.
2. To adjust the hood side to side, loosen the hinge-to-cowl attaching bolts and reposition the hinge as necessary.

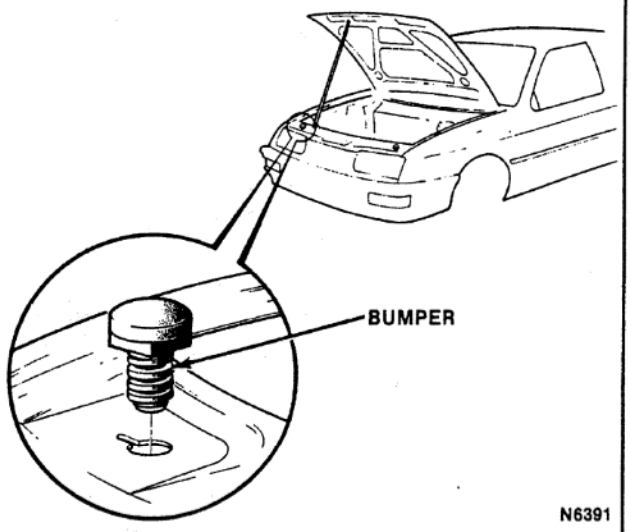
NOTE: Hood-to-hinge locations must be marked for reference before loosening bolts, as both up and down and fore and aft adjustments are affected.



HOOD BUMPERS

Hood bumpers, located on the top left and top right surface of the radiator support, can be adjusted up-and-down to provide a level surface alignment of the front of hood panel with the front fenders.

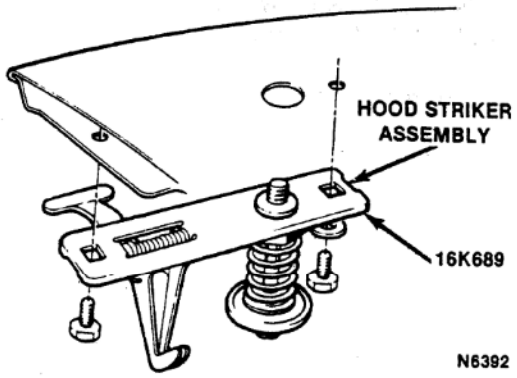
1. Adjust the bumpers on each side of the radiator support to align the front surface of the hood with front fenders.



ADJUSTMENTS (Continued)

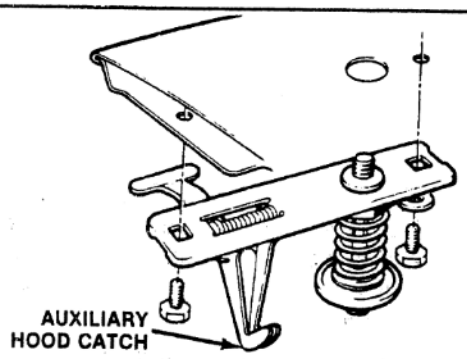
STRIKER

The striker should be adjusted so that it engages fully in the hood latch when the hood is level with the fenders.



AUXILIARY HOOD CATCH

Check the engagement of the auxiliary hood catch by releasing the hood latch to the pop-open position and pull up on the hood assembly. The catch should prevent the hood from opening. If not, adjust the auxiliary hood catch by loosening the two bolts and adjusting the catch until it is in line with the latch.

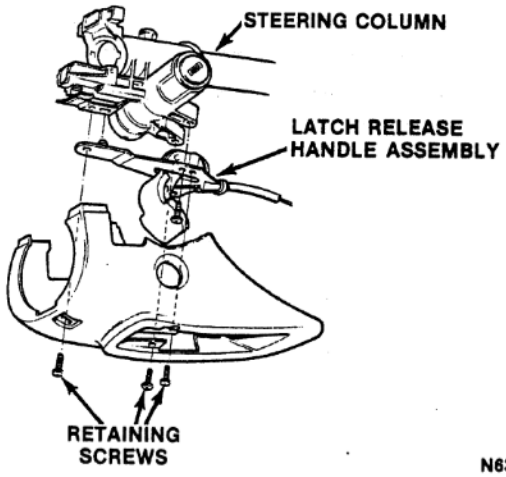


REMOVAL AND INSTALLATION

HOOD LATCH CONTROL CABLE

Removal

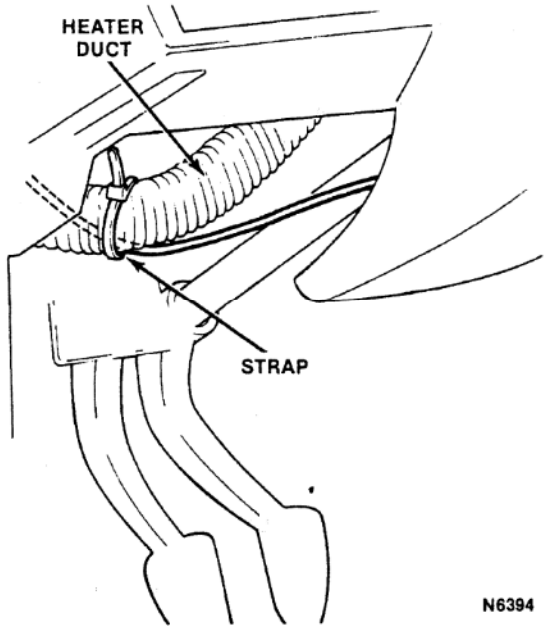
1. From inside the vehicle, open the hood.
2. Remove three retaining screws and detach cable shroud under the steering column. Remove one screw and detach latch release handle assembly from steering column.



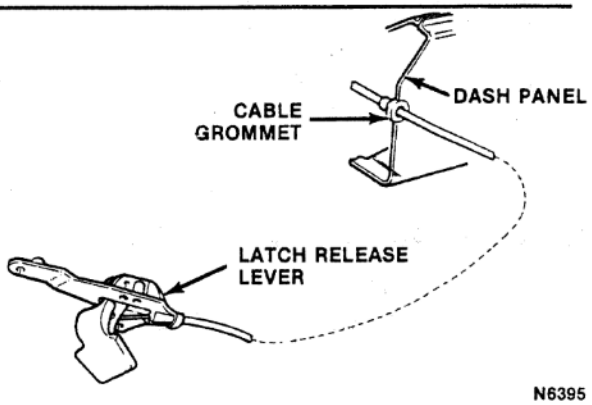
REMOVAL AND INSTALLATION (Continued)

HOOD LATCH CONTROL CABLE REMOVAL (Continued)

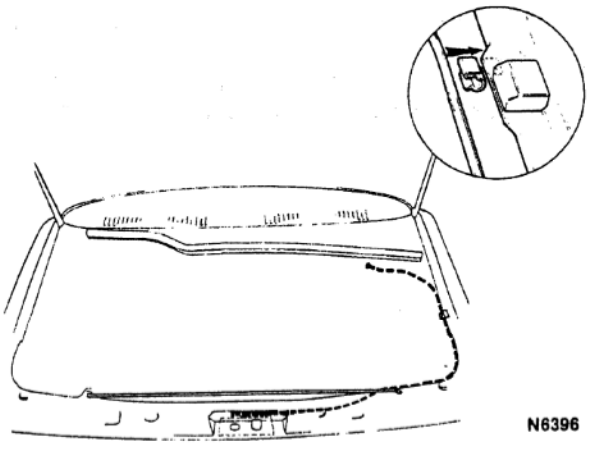
3. Remove strap on heater duct.



4. From inside engine compartment, remove three retaining screws from hood latch and remove latch through aperture in crossmember.
5. From inside engine compartment, pull outer cable grommet from latch cable retainer and disengage cable bushing from latch release arm.



6. Unclip cable from side of engine compartment.
7. Pull cable through dash panel into passenger compartment.



REMOVAL AND INSTALLATION (Continued)

HOOD LATCH CONTROL CABLE (Continued)

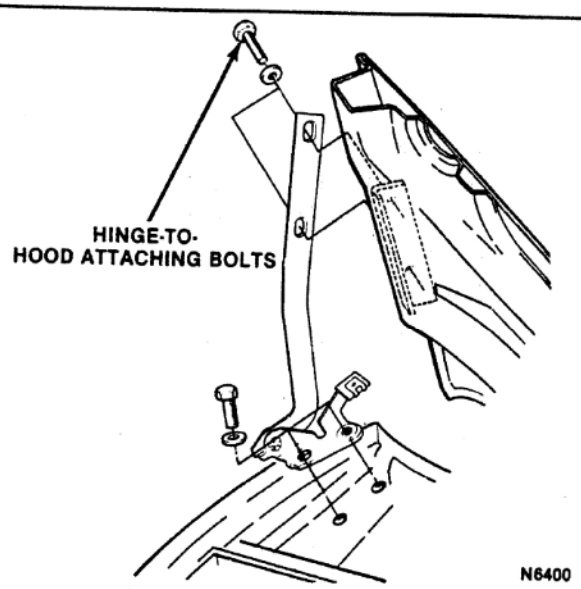
Installation

1. From inside passenger compartment, insert cable through hole in dash panel and locate grommet into the hole.
2. From inside engine compartment, feed cable into crossmember and install cable bush into hood latch lever and the cable grommet into cut-out in lever bracket. Reinstall hood latch.
3. Slot cable into clips on side of engine compartment.
4. From inside passenger compartment, position bracket to steering column and install retaining screw.
5. Restrap cable to heater duct ensuring the cable is clear of the clutch.
6. Reinstall steering column shroud and attach the three retaining screws.
7. Check the hood latch cable release operation before closing the hood.

HOOD

Removal

1. Protect the body with covers to prevent damage to the paint.
2. Remove the two bolts attaching each hinge to the hood, taking care not to let the hood slip when the bolts are removed.



3. Remove the hood from the vehicle.

Installation

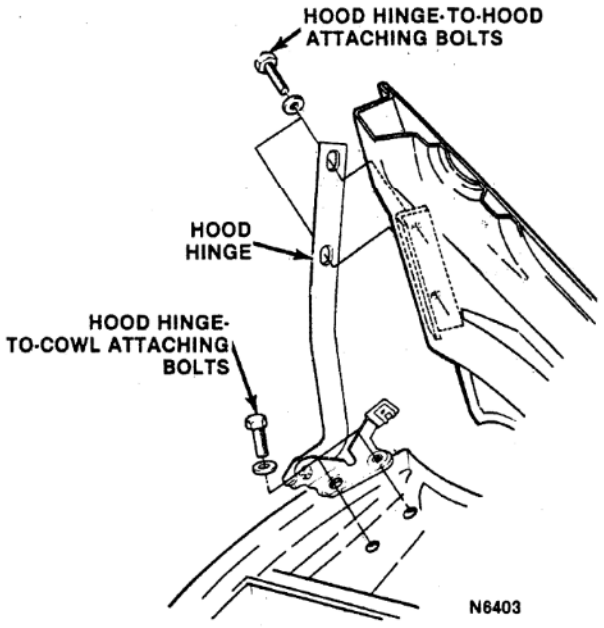
1. Position the hood to the hood hinges and install the attaching bolts. Remove the body cover.
2. If necessary, adjust height of bumper stops.
3. Adjust auxiliary hood catch so it engages fully in the hood lock and the hood is level with the fenders.

REMOVAL AND INSTALLATION (Continued)

HOOD HINGE

Removal

1. Remove cowl top panel cover.
2. Open the hood and cover the fenders and cowl top panel.
3. Prop the hood in the open position and remove two hood hinge-to-hood bolts.
4. Remove two hinge-to-cowl bolts and remove the hinge.



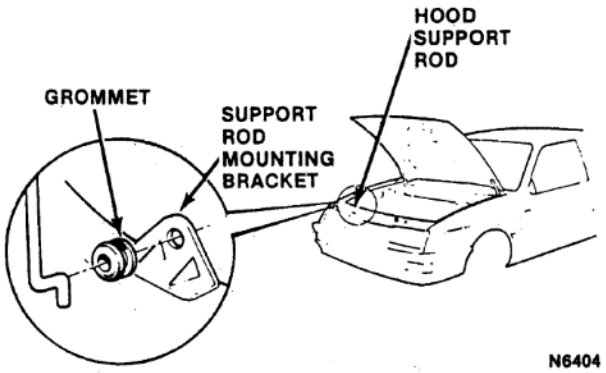
Installation

1. Position the hinge to cowl and install the two attaching bolts.
2. Position the hinge to the hood and install the two attaching bolts.
3. Adjust the hood.
4. Reinstall cowl top panel cover.

HOOD SUPPORT ROD

Removal

1. Open hood and temporarily support hood in open position with something other than the support rod.
2. Remove support rod from stored position.
3. Remove support rod from grommet in support rod mounting bracket.



Installation

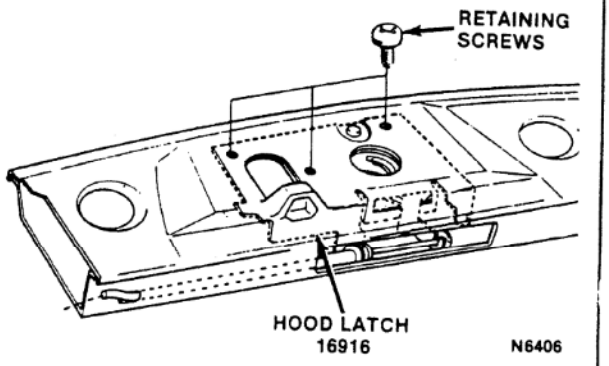
1. Insert support rod through grommet in support rod mounting bracket.
2. Store hood support in the stored position and remove temporary support.

REMOVAL AND INSTALLATION (Continued)

HOOD LATCH

Removal

1. Remove the three latch attaching screws and remove the latch assembly from crossmember.



2. Disengage cable away from the hood latch assembly.

Installation

1. Position the hood latch control cable to the latch assembly and install the cable.
2. Position the latch assembly to the vehicle and install the three attaching screws.

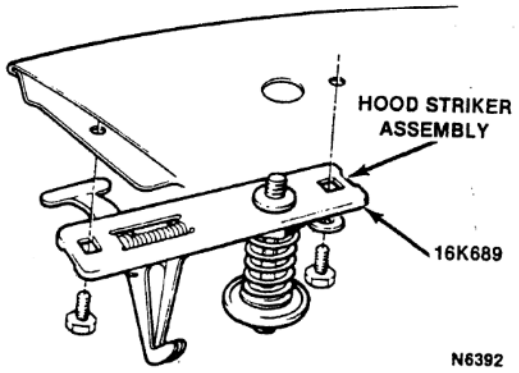
STRIKER

Removal

Remove lock striker and safety catch by removing two bolts.

Installation

1. Reinstall lock striker. Adjust lock striker so that it engages fully in the hood lock and the hood is level with the fenders. Tighten bolts to 8.5–11.5 N·m (6.3–8.5 lb-ft).



2. If necessary, adjust height of hood bump stops.

SECTION 44-41 Liftgate Door, Latch, Lock and Weatherstrip

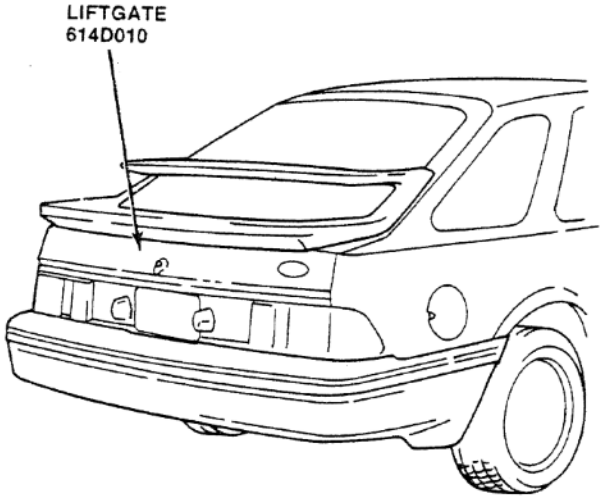
SUBJECT	PAGE
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Liftgate Up-and-Down, Side-to-Side	44-41-2
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Liftgate Latch and Lock Barrel	44-41-2
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Remote Liftgate Release Solenoid (If Equipped)	44-41-2

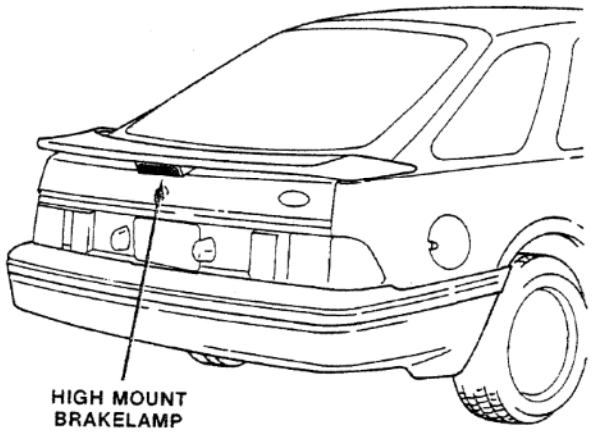
DESCRIPTION

The liftgate assembly pivots on two hinges assisted by two gas springs. The hinge retaining nuts are accessible through two openings in the molded headlinings that are concealed behind the molded covers. The hinges are welded to the liftgate.

If equipped with a remote liftgate release solenoid, a switch mounted in the center console actuates a solenoid which is an integral part of the luggage compartment latch assembly. A new liftgate incorporating larger glass is used on 1988 models.



1987 AND EARLIER MODELS



1988 MODELS

N8101-A

ADJUSTMENTS

Liftgate Up-and-Down, Side-to-Side

The liftgate can be adjusted up and down or side to side by loosening the header roof frame attaching bolt and washer. The liftgate can be adjusted upwards by shimming the hinges at the header roof frame. The liftgate should be adjusted for an even parallel fit with liftgate openings and surrounding panels.

1. Remove molded covers from headlining to gain access to the hinge retaining nuts.
2. Adjust the hinge(s) as necessary.
3. Seal the hinge to body with clear silicone sealer DZAZ-19562-A, or equivalent.
4. Install molded covers back into headlining opening.

Liftgate Latch Striker Plate

The liftgate striker can be adjusted up or down to adjust the liftgate fit relative to surrounding panels.

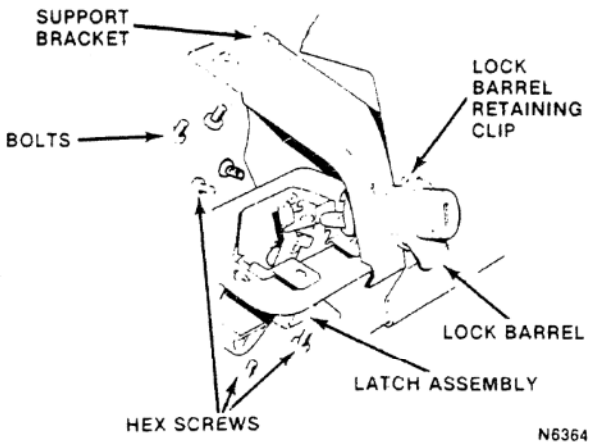
1. Clean the latch jaws and striker.
2. Loosen the three bolts and washer assemblies attaching the striker plate to the rear body panel.
3. Move the plate up and down as necessary. Tighten bolts to 9 to 11 N·m (6.5 to 8 lb-ft).

REMOVAL AND INSTALLATION

Liftgate Latch and Lock Barrel

Removal

1. Open the liftgate assembly and remove liftgate trim panel.
2. Remove the lock barrel retaining clip and remove the lock barrel.
3. Remove the two bolts retaining the support bracket and remove the support bracket.
4. Remove the four hex screws retaining the latch assembly and remove the latch assembly.



Installation

1. Position the latch assembly in the liftgate and retain with four hex screws tightened to 9 to 11 N·m (6.5 to 8 lb-ft).
2. Install the support bracket and retain with two bolts.
3. Insert the door lock barrel through the opening in the liftgate. Retain the door lock barrel with the retaining clip.
4. Reinstall the liftgate trim panel.

Remote Liftgate Release Solenoid (If Equipped)

Removal

1. Remove the liftgate latch as detailed in the preceding procedure.
2. Remove the two retaining screws securing the solenoid to the latch assembly. Disconnect the connecting rod. Remove the solenoid.

Installation

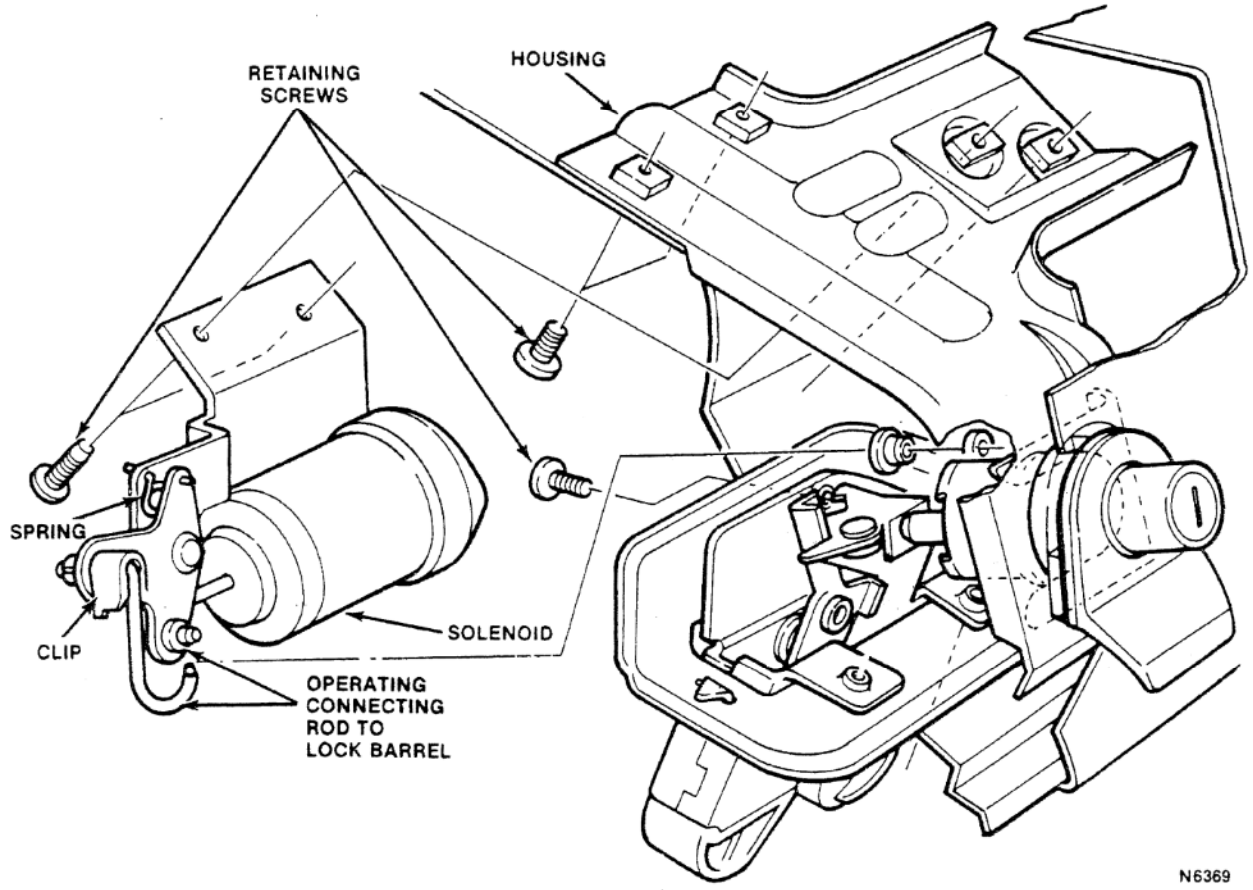
1. Position the solenoid to the latch assembly.
2. Connect the connecting rod from the solenoid operating crank to the latch. Attach the solenoid to the latch assembly with the two retaining screws. Tighten screws to 1 to 1.5 N·m (0.7 to 1 lb-ft).

REMOVAL AND INSTALLATION (Continued)

Liftgate Central Locking Solenoid

Removal

1. Open the liftgate and remove the liftgate trim panels.
2. Disconnect the wiring harness connection and ground wire from the wiring harness at the liftgate.
3. Remove the clip from the operating rod and detach rod.
4. Remove the two screws retaining solenoid to housing and remove solenoid.



Installation

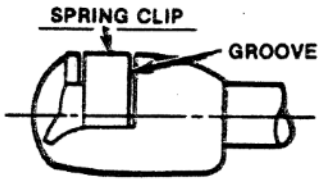
1. Position the solenoid to the housing and install the two screws.
2. Attach the housing to the latch and install the clip and operating rods.
3. Reconnect the wiring harness and test the operation of the system.
4. Install the liftgate trim panel and close the liftgate.

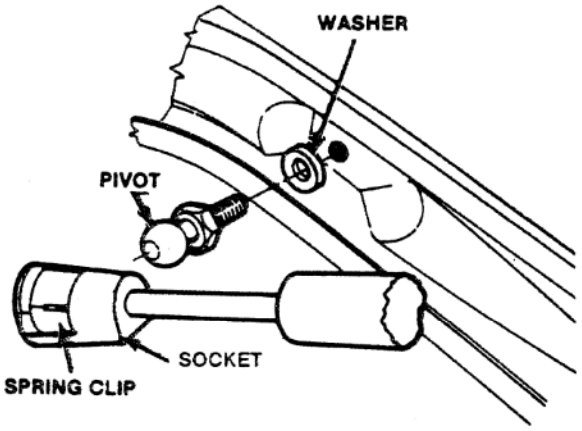
REMOVAL AND INSTALLATION (Continued)

Gas Spring

Removal

1. Open the liftgate and support the liftgate in the raised position with a prop.
2. Insert small lever underneath the spring clip, and raise the clip about 5mm.
3. Pull the gas spring gently from the pivot.
4. Repeat steps 2 and 3 for the gas spring on the other side of the vehicle.





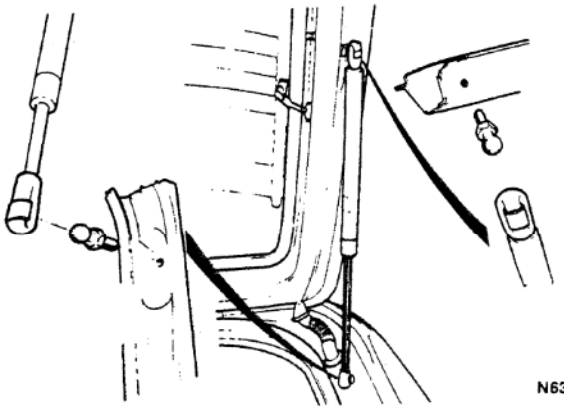
Installation

1. Locate the socket over the pivot and push the gas spring into place.
2. Check that the gas spring is seated properly.
3. Remove the prop and close the liftgate.

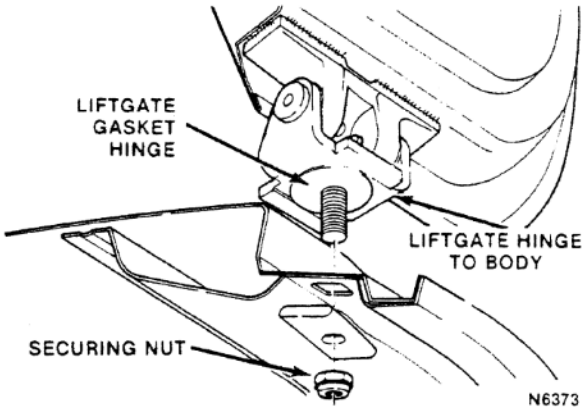
Liftgate Assembly

Removal

1. Open the liftgate and disconnect all electrical connections to the liftgate.
2. Release loom grommets. Connect drawstring to looms/pipes and pull the drawstring through the liftgate.
3. Support the liftgate with props and remove both gas springs from the liftgate. Refer to above removal procedure.



4. Remove molded covers from headlining to gain access to hinge retaining nuts.
5. Remove the securing nuts and washer-plate from each hinge and remove the liftgate.



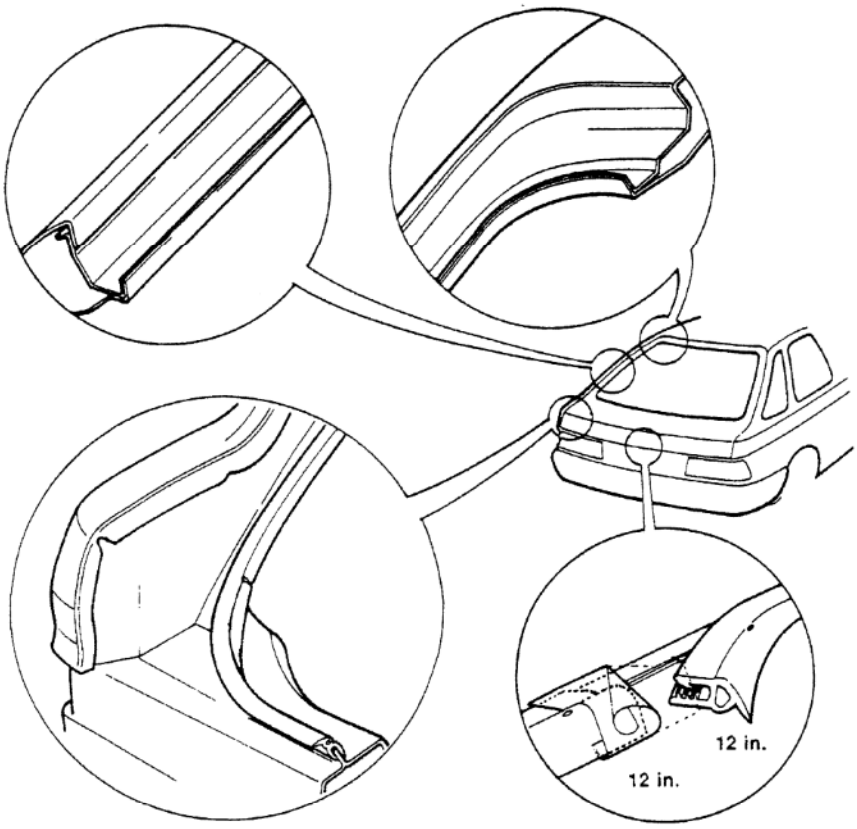
Installation

1. Position the liftgate hinge studs and install the securing nuts and washer-plate. Support the liftgate with props.
2. Reconnect the gas springs. Attach drawstring to looms/pipes and pull the drawstring through the liftgate.
3. Reinstall grommets to the liftgate.
4. Reconnect all electrical connections and adjust the liftgate as necessary.

REMOVAL AND INSTALLATION (Continued)

Liftgate Weatherstrip

The weatherstrip is mechanically retained. No adhesive is required for retention.



INTERIOR TRIM

GROUP 45

TITLE SECTION	PAGE NO.	TITLE SECTION	PAGE NO.

INTERIOR TRIM PANELS 45-03

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- Door Trim Panels 1
- Door Trim Panel Insert 3
- Center Pillar Trim Panel 4
- Center Pillar Trim Panel Insert 5
- Quarter Trim Panel 6
- Cowl Trim Panel 7
- Liftgate Trim Panel 8
- Rear Quarter Trim Panel 8
- A-Pillar Trim Panel 11

REAR PARCEL TRAY 45-21

DESCRIPTION 1
REMOVAL AND INSTALLATION 1

CARPETS AND FLOOR MATS 45-26

REMOVAL AND INSTALLATION 1

FLOOR CONSOLE 45-31

DESCRIPTION 1
REMOVAL AND INSTALLATION 1

HEADLINING 45-41

DESCRIPTION 1
REMOVAL AND INSTALLATION
- Sun Visor with Lamp 2
- Headlining 2

INSTRUMENT PANEL PAD 45-61

REMOVAL AND INSTALLATION 1

SECTION 45-03 INTERIOR TRIM PANELS

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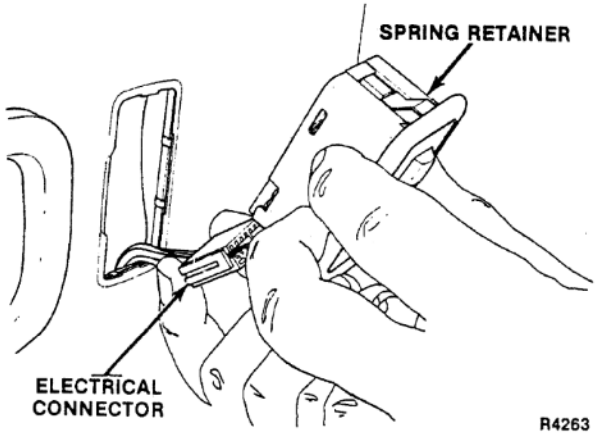
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Quarter Trim Panel	6
Cowl Trim Panel	7
Liftgate Trim Panel	8
Rear Quarter Trim Panel	8
A-Pillar Trim Panel	11

REMOVAL AND INSTALLATION

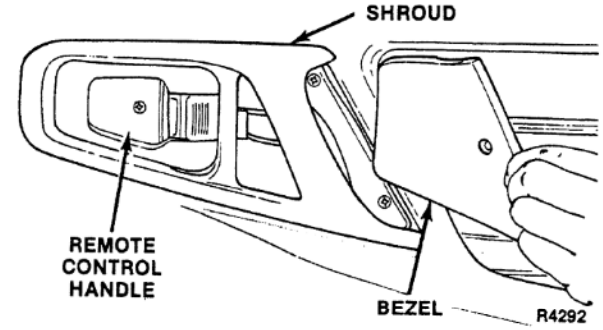
DOOR TRIM PANELS

Removal

1. Remove power mirror switch from driver door trim panel by depressing spring retainer. Disconnect electrical connector. (Driver's Door Only)



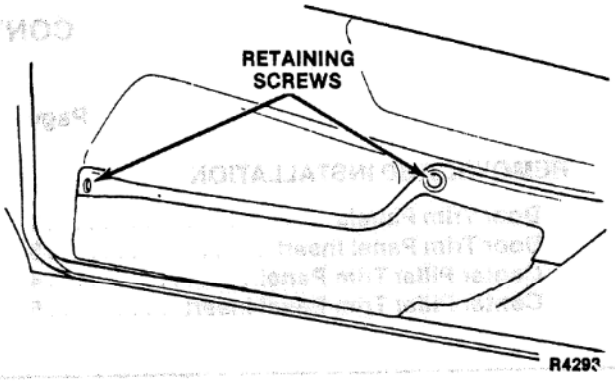
2. Remove remote control handle bezel assembly.



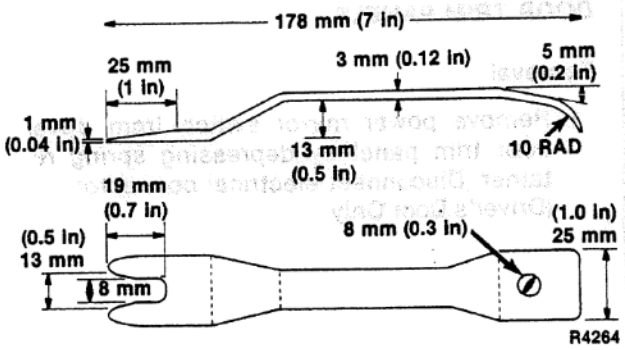
REMOVAL AND INSTALLATION (Continued)

DOOR TRIM PANELS REMOVAL (Continued)

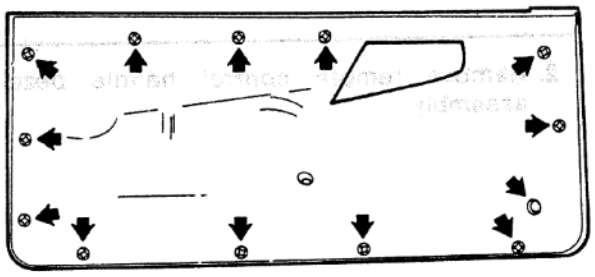
3. Remove the two retaining screws to the map stowage pocket. Remove the map stowage pocket.



4. Using the fabricated tool shown, carefully detach the four trim retaining clips along the bottom edge of the trim panel.



5. To remove the trim from the door, run fingers beneath the side of the trim board. Pull gently at the locations of the side trim push pin retainers. The curved end of the tool can be used for additional leverage in the retainer area if necessary.
6. Continue to run fingers around the edge of the trim until all the clips are released. If any clip requires excessive force to remove, insert a sharp chisel behind the trim to cut the head from the clip.



Installation

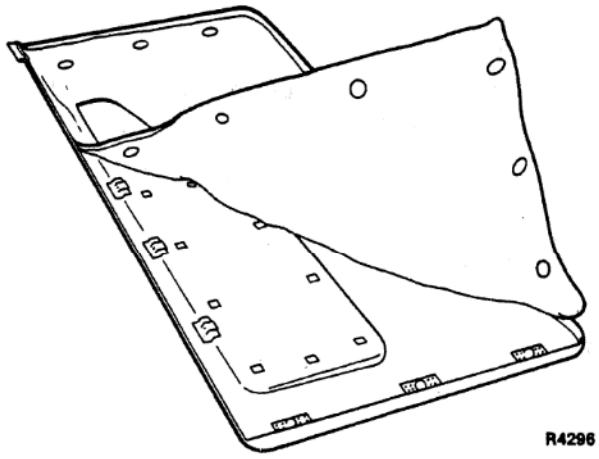
1. Check the condition of the trim retainers and replace if damaged. Align retainers with apertures in the door inner panel. Push in to secure.
2. Reinstall the map pocket assembly with the three retaining lugs, two screws and one clip.
3. Reinstall remote control handle bezel assembly shroud.
4. On the driver's door, reconnect the power mirror switch and snap in to door.

REMOVAL AND INSTALLATION (Continued)

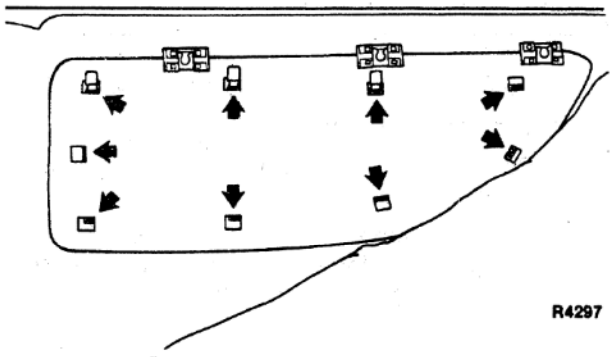
DOOR TRIM PANEL INSERT

Removal

1. Remove door trim panel as detailed above.
2. Remove polyurethane pad covering back of door trim panel.

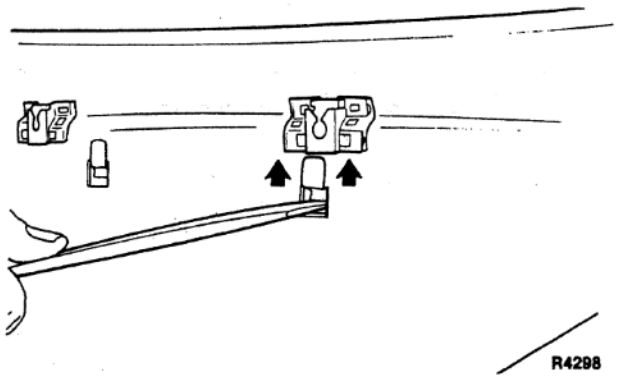

R4296

3. Pry out nine clips retaining door trim panel insert with a screwdriver.
4. Remove door trim panel insert.


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Installation

1. Install door trim panel insert over door trim panel.
2. Install the nine retaining clips by pressing the clips in with a screwdriver.
3. Reinstall polyurethane pad covering back of door trim panel.
4. Install door trim panel as detailed above.

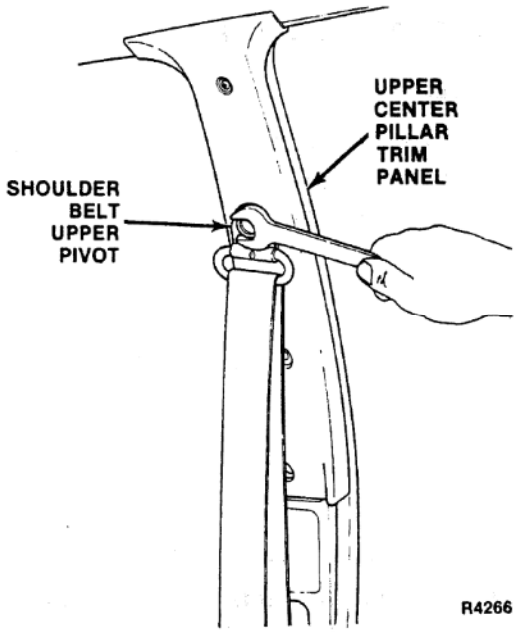

R4298

REMOVAL AND INSTALLATION (Continued)

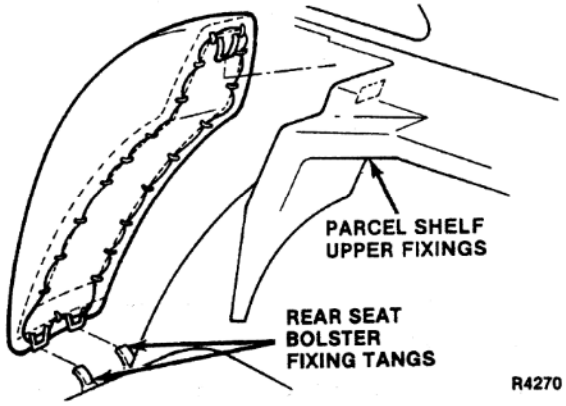
CENTER PILLAR TRIM PANEL

Removal

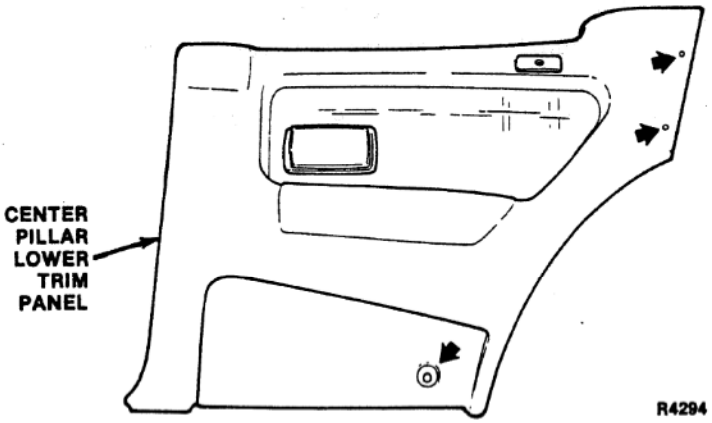
1. Remove the shoulder belt upper pivot and its moulding.



2. Remove upper center pillar trim panel.
3. Slide front seat fully forward.
4. Pull rear seat cushion forward and fold down rear seat back.
5. Carefully bend back lower rear seat bolster fixing tangs. Unhook bolster assembly from upper fixings in parcel shelf.



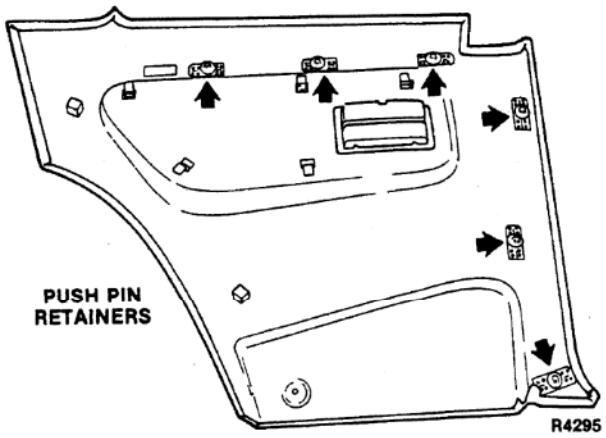
6. Remove three screws retaining center pillar lower trim panel.



REMOVAL AND INSTALLATION (Continued)

CENTER PILLAR TRIM PANEL (Continued)

7. To remove the trim from the center pillar, run fingers beneath the side of the trim board. Pull gently at the locations of the center pillar push pin retainers. The curved end of the tool shown on 45-03-02 can be used for additional leverage in the retainer area if necessary.
8. Continue to run fingers around the edge of the trim until all the retainers are released and remove the center pillar trim panel.



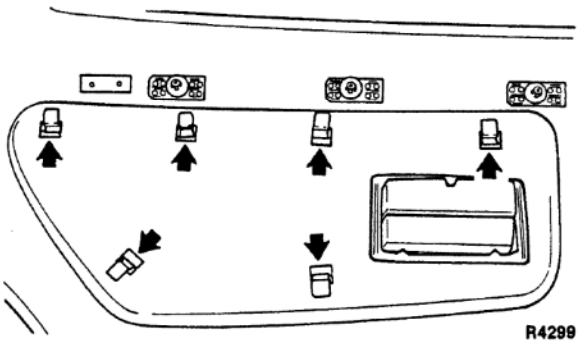
Installation

1. Check the condition of the trim retainers and replace if damaged. Align retainers with apertures in the center pillar inner pad. Push in to secure.
2. Reverse steps 1 through 6 of the removal procedure.

CENTER PILLAR TRIM PANEL INSERT

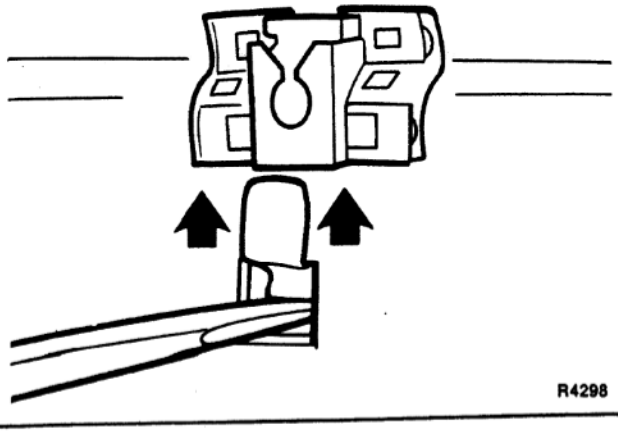
Removal

1. Remove center pillar trim panel as detailed above.
2. Pry out six clips retaining center pillar trim panel insert.
3. Remove center pillar trim panel insert.
4. To install, reverse steps 1 through 3.



Installation

1. Install center pillar trim panel insert over center pillar trim panel.
2. Install the six retaining clips by pressing the clips in with a screwdriver.
3. Reinstall center pillar trim panel as detailed above.

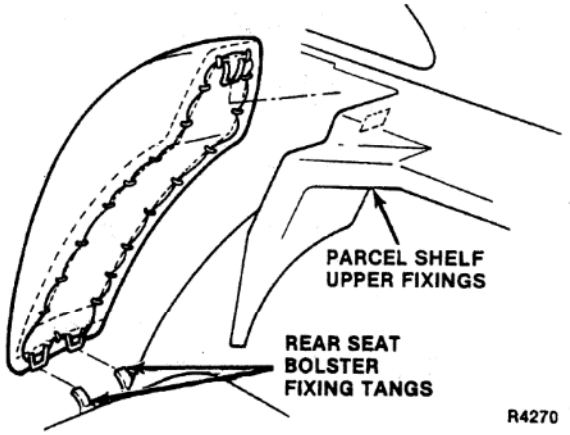


REMOVAL AND INSTALLATION (Continued)

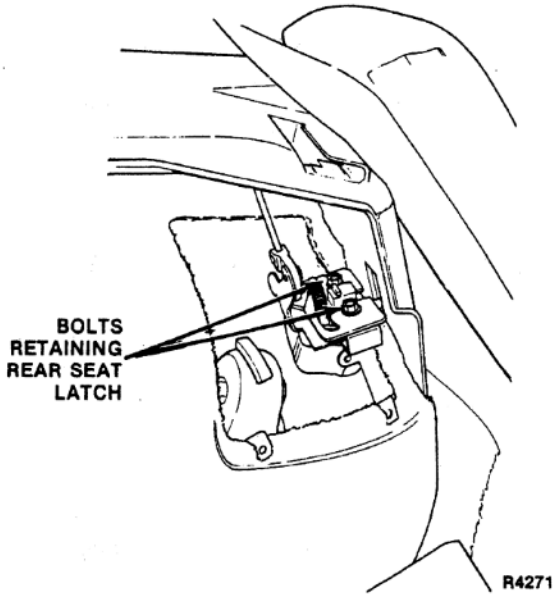
QUARTER TRIM PANEL

Removal

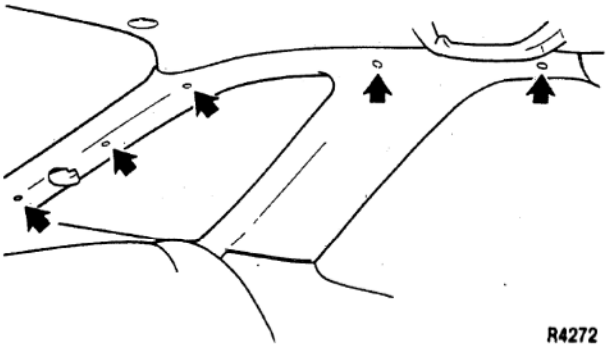
1. Fold down rear seat back.
2. Carefully bend back lower rear seat bolster fixing tangs. Unhook bolster assembly from upper fixing in parcel shelf.



3. Remove rear parcel shelf.
4. Remove nine screws retaining rear parcel shelf bracket. Remove two bolts retaining rear seat latch assembly to wheel arch. Remove rear parcel shelf bracket.
5. Remove two bolts retaining rear seat latch assembly to wheel arch.



6. Remove rear parcel shelf bracket.
7. Remove five screws and detach quarter trim panel.



REMOVAL AND INSTALLATION (Continued)

QUARTER TRIM PANEL (Continued)

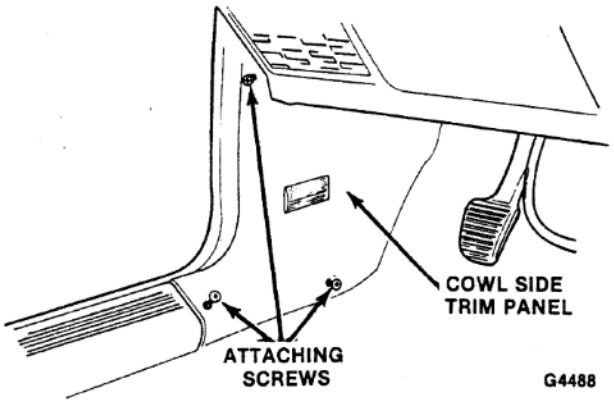
Installation

1. Position quarter trim panel and install five retaining screws.
2. Install rear parcel shelf bracket and install nine retaining screws. Install two bolts retaining rear seat latch assembly to wheel arch.
3. Install rear parcel shelf.
4. Install upper hook of rear seat bolster into parcel shelf bracket. Align bolster and bend lower fixing tangs over hooks to secure.
5. Fold up rear seat back. Check operation of rear seat catch.

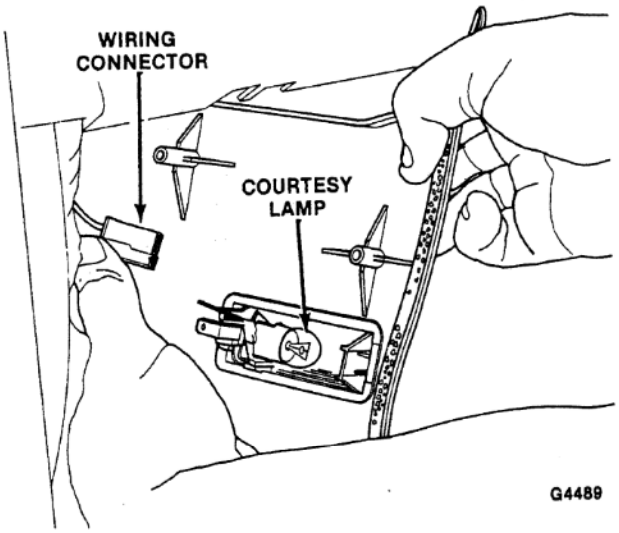
COWL TRIM PANEL

Removal

1. Remove the insulation panel from below the instrument panel.
2. Remove the cowl side trim panel attaching screws.



3. Pull the cowl side trim panel away from the body, disconnect the courtesy lamp wires and remove the panel.



Installation

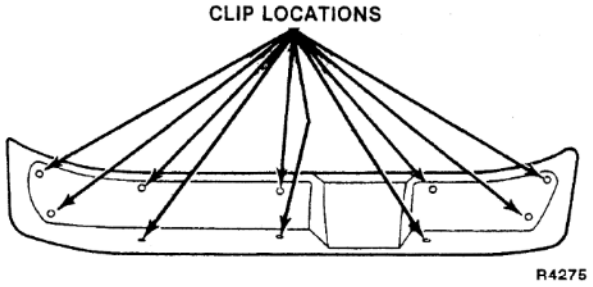
1. Reverse removal procedures.

REMOVAL AND INSTALLATION (Continued)

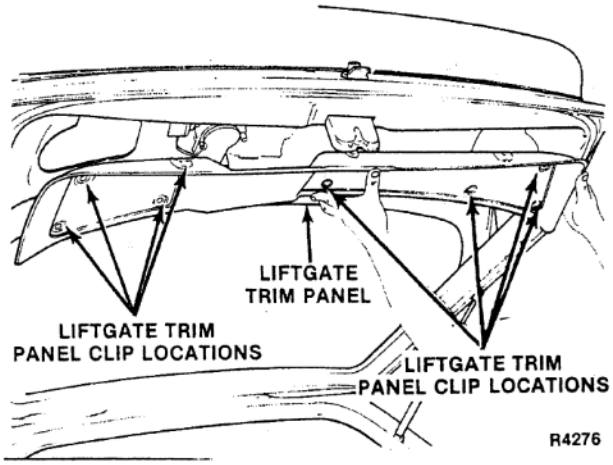
LIFTGATE TRIM PANEL

Removal

1. Remove ten clips from liftgate trim panel.



2. Pull liftgate trim panel away from liftgate.



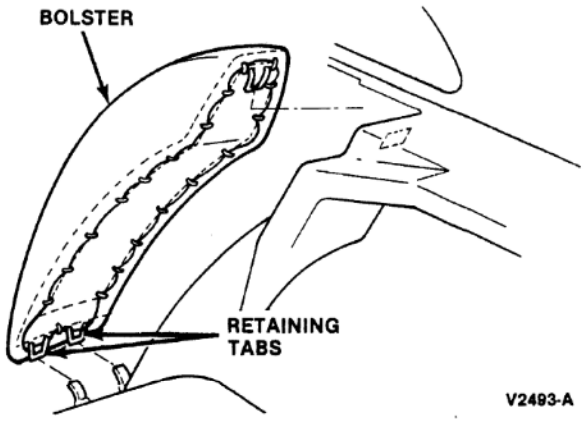
Installation

1. Reverse removal procedures.

REAR QUARTER TRIM PANEL

Removal

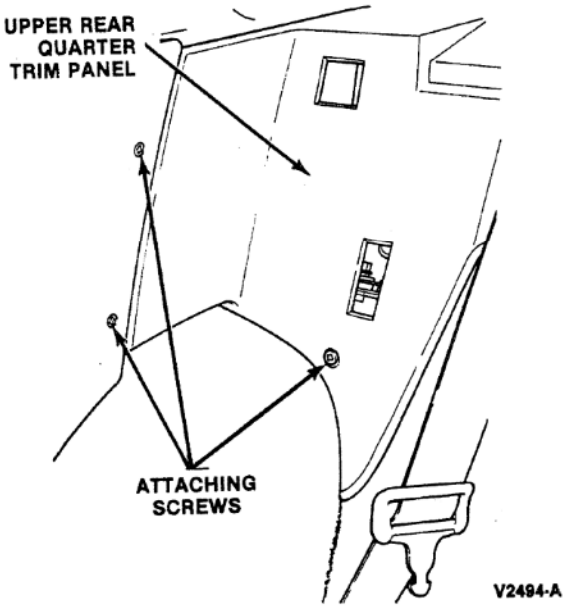
1. Lower the rear seat backs and remove the luggage compartment carpeting.
2. Push the rear seat back upward into position and pull the seat cushion forward.
3. At the bottom of the seat bolster, bend the retaining tabs upward.



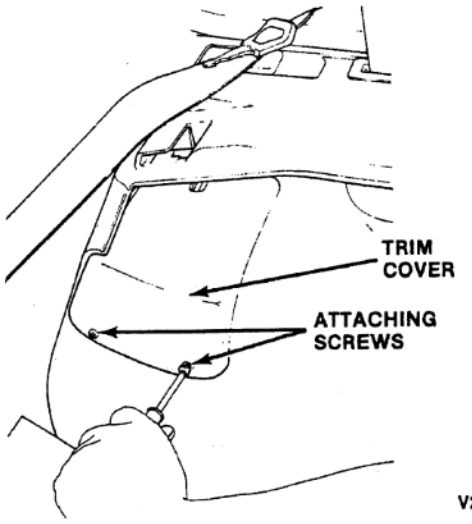
REMOVAL AND INSTALLATION (Continued)

REAR QUARTER TRIM PANEL (Continued)

4. Push upward on the bolster to disengage the upper retainer and remove the bolster.
5. Remove three upper rear quarter trim panel attaching screws.



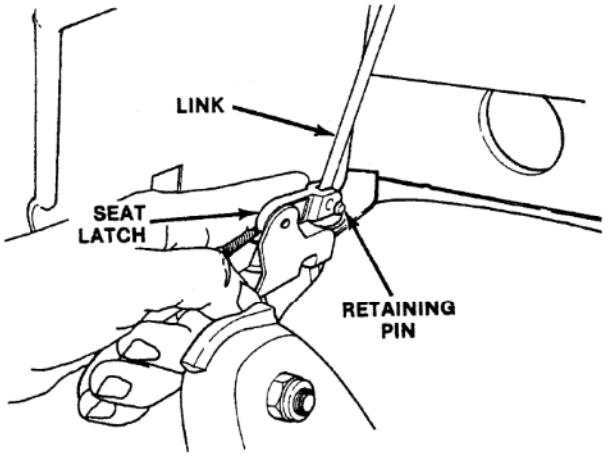
6. Remove the shock tower trim panel.



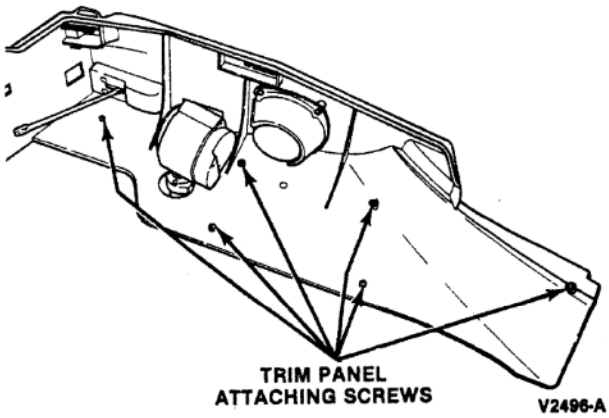
REMOVAL AND INSTALLATION (Continued)

REAR QUARTER TRIM PANEL (Continued)

7. Remove the seat latch link retaining pin.



8. Remove six upper rear quarter trim panel attaching screws.
9. Remove the lower rear quarter trim panel push retainer.
10. Remove the lower rear quarter trim panel.



Installation

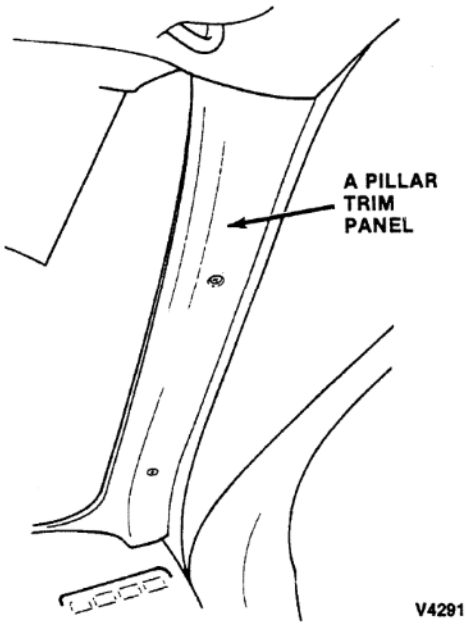
1. Install the lower rear trim panel. Make sure the upper edge of the panel is positioned under the upper rear quarter trim panel.
2. Install the lower rear quarter trim panel push retainers.
3. Install the six upper rear quarter trim panel attaching screws.
4. Position the seat back latch link and install the retaining pin.
5. Install the shock tower cover.
6. Install the three upper rear quarter trim panel attaching screws.
7. Position the seat bolster, push inward at the top and reach behind the trim panel with a screwdriver to snap the retainer into position.
8. Push inward on the lower end of the bolster and bend the retaining tabs downward.
9. Position the rear seat cushion and position the rear seat back down.
10. Install the luggage compartment carpeting.

REMOVAL AND INSTALLATION (Continued)

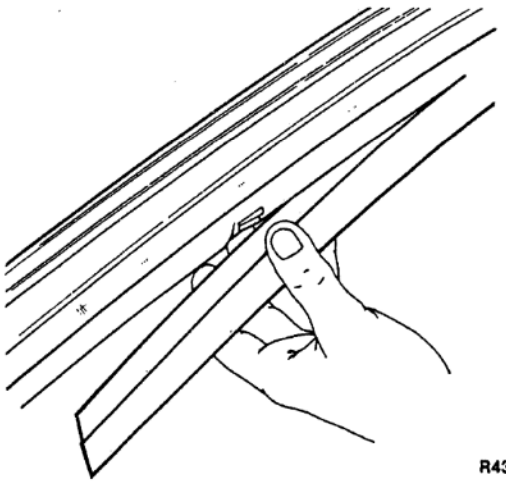
A-PILLAR TRIM PANEL

Removal and Installation

1. Remove the two retaining screws. Remove the trim panel.



2. Position the A-pillar trim panel and install the two retaining screws.



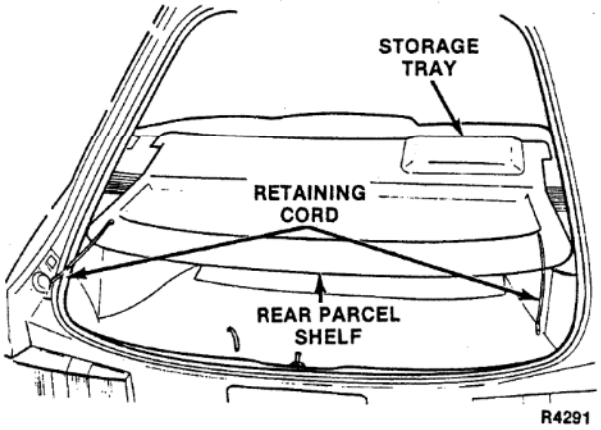
SECTION 45-21 REAR PARCEL TRAY

CONTENTS

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DESCRIPTION 1

REMOVAL AND INSTALLATION 1



DESCRIPTION

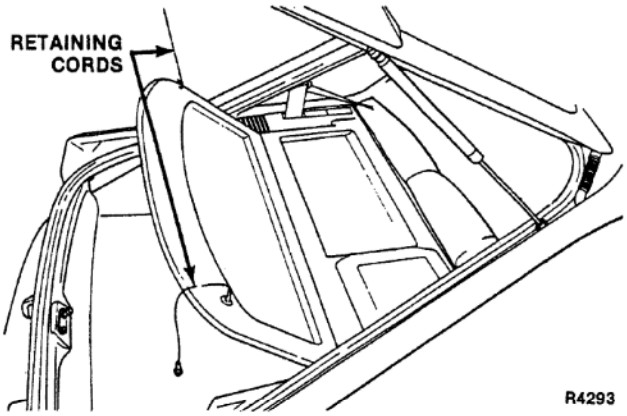
The rear parcel tray is located between the rear seatback and the liftgate window. A small storage area is built into the parcel tray on the right-hand side.

REMOVAL AND INSTALLATION

REAR PARCEL TRAY

Removal

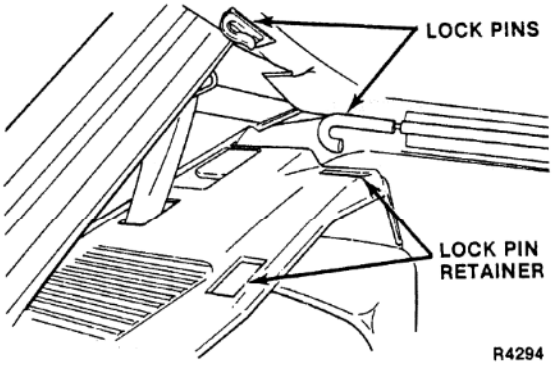
1. Unhook retaining cord from the buttons on the liftgate.



REMOVAL AND INSTALLATION (Continued)

REAR PARCEL TRAY REMOVAL (Continued)

2. Pull the parcel tray toward the rear of the vehicle to clear the lockpins and lift the parcel tray for removal.



Installation

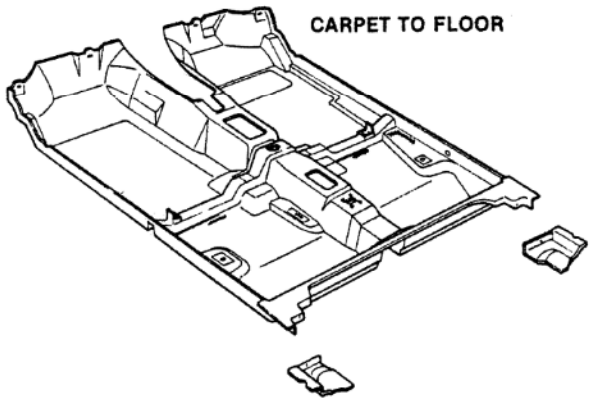
1. To install, reverse removal steps 1 and 2.

SECTION 45-26 CARPETS AND FLOOR MATS

CONTENTS

Page

REMOVAL AND INSTALLATION 1

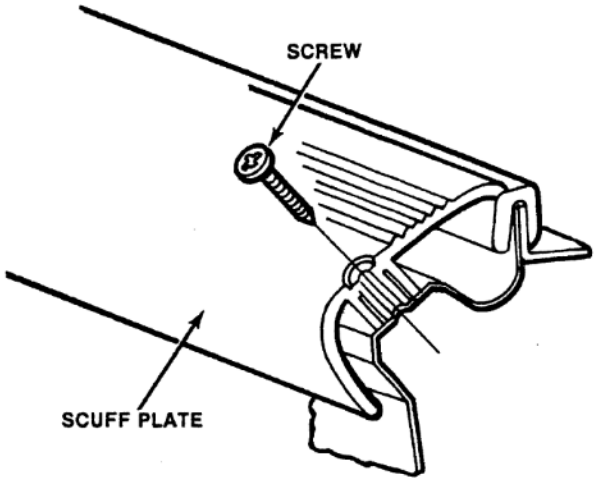


REMOVAL AND INSTALLATION

CARPETS

Removal

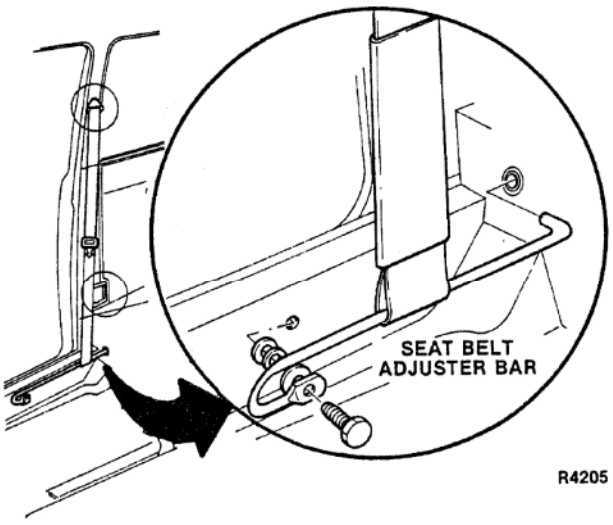
1. Remove both front seats.
2. Remove floor console.
3. Remove cowl side trim panels. Refer to Section 45-03.
4. Remove screw from upper "B" pillar trim panel and move panel to gain access to two screws retaining upper edge of lower "B" pillar trim panel. Remove two lower "B" pillar screws and detach lower "B" pillar trim panel.
5. Pull out and push back carpet. Remove two push pins.
6. Remove two screws from each scuff plate and remove scuff plates.



REMOVAL AND INSTALLATION (Continued)

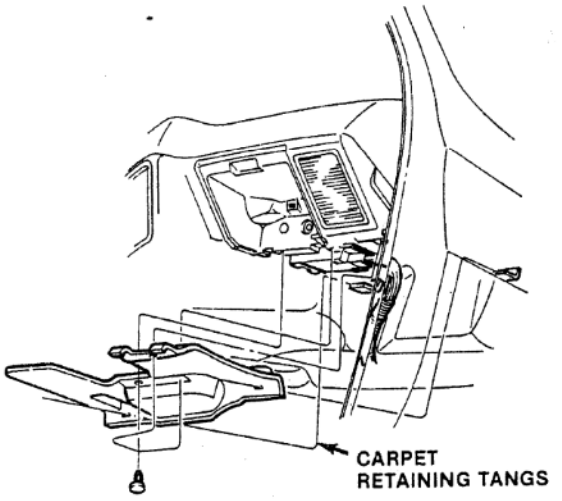
CARPETS (Continued)

7. Remove rear seat cushions.
8. Remove front seat belt adjuster bar. Refer to Section 41-50.



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9. Remove carpet retaining tangs on under-dash cover panel and lift out carpet assembly.



N4612

Installation

1. Position carpet into vehicle. Install under-dash cover panel. Install four fixing tangs through hole in front face of carpet and bend tangs over to properly seat them.
2. Install seat belts and seat belt outboard retainers.
3. Install rear seat cushions.
4. Install scuff plates and their two retaining screws.
5. Install floor console.
6. Install front seats.
7. Install cowl side trim panels.

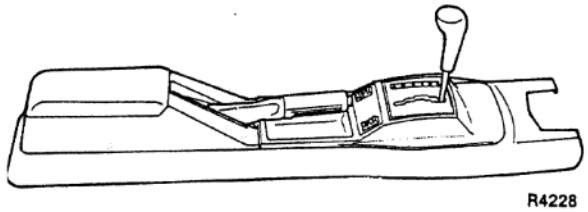
SECTION 45-31 FLOOR CONSOLE

CONTENTS

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REMOVAL AND INSTALLATION	1

DESCRIPTION

The floor console assembly incorporates a rear storage compartment with a hinged lid that can be used for storing cassettes. When closed, the storage compartment lid serves as an armrest. The console shrouds the parking brake and transmission control levers. Switches for power window operation (if equipped) are also mounted on the console.



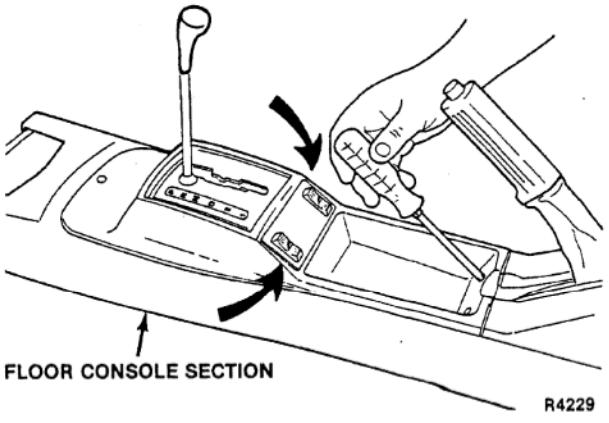
R4228

REMOVAL AND INSTALLATION

FLOOR CONSOLE

Removal

1. Remove three screws retaining the front section to the console base. Disconnect the power window switch and remove the section. It may be necessary to pinch console at the "arrows" indicated to dislodge internal tangs.

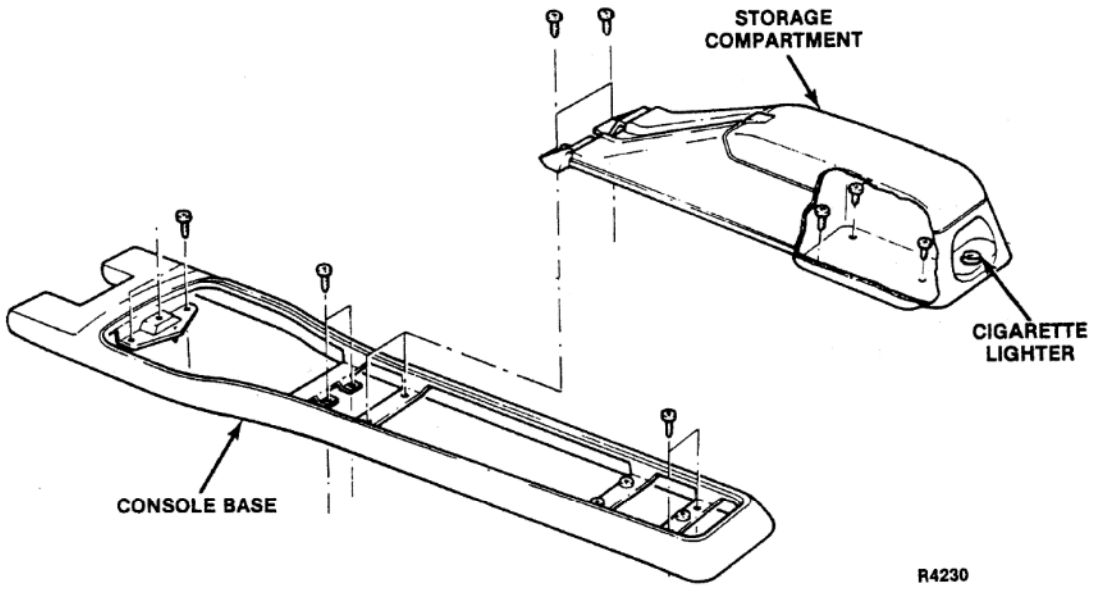


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REMOVAL AND INSTALLATION (Continued)

FLOOR CONSOLE (Continued)

2. Remove five screws retaining the storage compartment to the console base. Disconnect the cigarette lighter wires and remove the storage compartment.



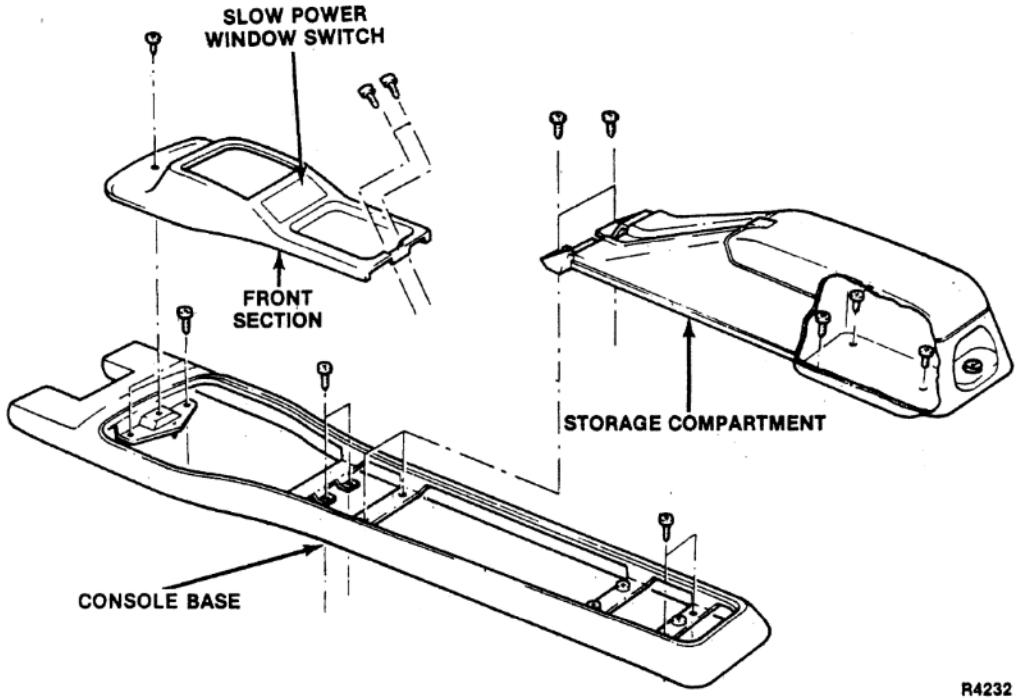
3. Remove six screws from console base and remove assembly.

REMOVAL AND INSTALLATION (Continued)

FLOOR CONSOLE (Continued)

Installation

1. Position console base and install six retaining screws.
2. Position storage compartment and reconnect cigarette wires. Install five retaining screws.



3. Position front section onto console base and install power window switches (if equipped) and install three screws retaining section to console base.

SECTION 45-41 HEADLINING

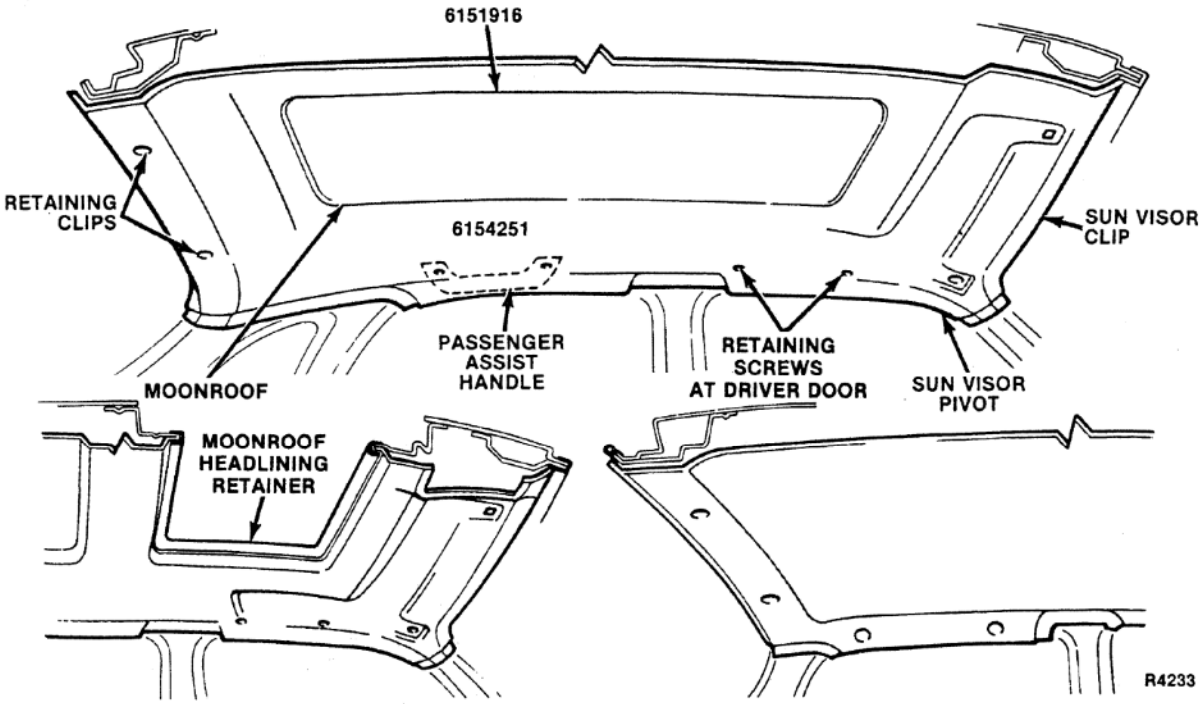
CONTENTS

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DESCRIPTION 1

REMOVAL AND INSTALLATION

Sun Visor with Lamp 2
Headlining 2



DESCRIPTION

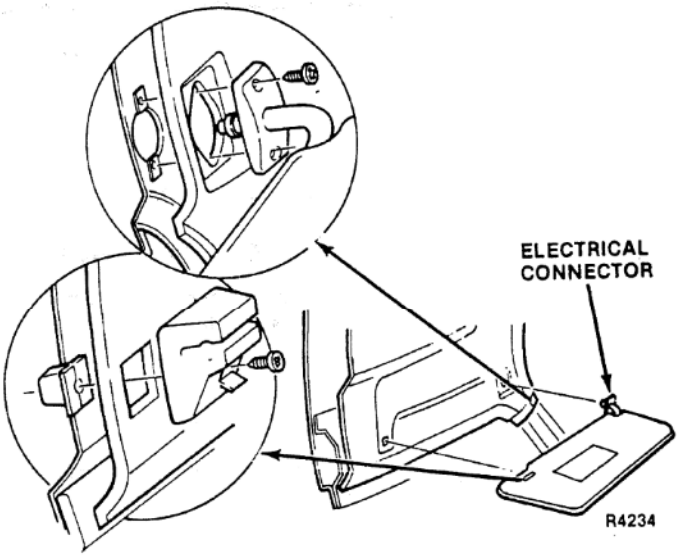
The vehicle is equipped with a one-piece molding headlining. The molding is retained by the sun visor fixings, passenger assist handles, concealed screws, and the quarter turn fasteners. Sun visors, passenger assist handles, and quarter turn fasteners in the rear header at the upper driver door and liftgate locations must be removed to remove the headlining. In addition, if the vehicle is equipped with a sliding roof, it must be removed. The headlining folds around the sliding roof aperture flange and is held in place with a molding which must also be removed.

REMOVAL AND INSTALLATION

SUN VISOR WITH LAMP

Removal

1. Remove attaching screws.



2. Disconnect vanity mirror electrical connector.
3. Disengage sun visor from clip.

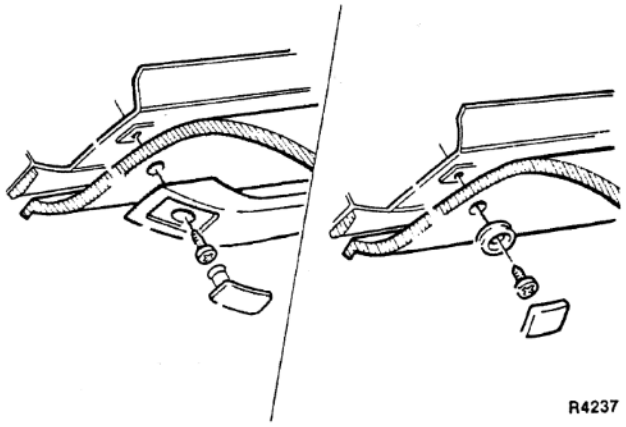
Installation

1. Reconnect electrical connector.
2. Insert sun visor into clip.
3. Install attaching screws.

HEADLINING

Removal

1. Remove sliding roof, if applicable.
2. Remove sun visors and retaining brackets.
3. Loosen and remove upper screws of A, B and C pillar trims.
4. Remove passenger assist handles. First remove the cover by prying it off with your finger. Then remove the two retaining screws on the handle.
5. Remove two screws at driver upper door.
6. Remove two quarter turn fasteners from fastener apertures in rear header area and lower headlining. Remove headlining from vehicle through liftgate opening.

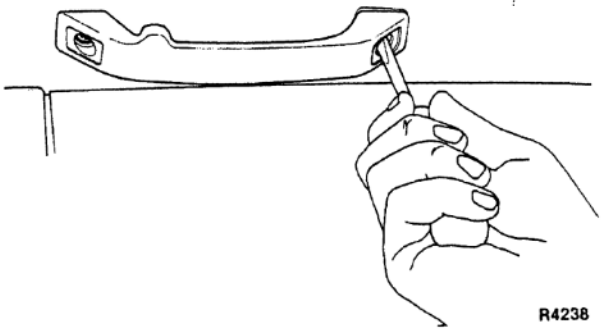


REMOVAL AND INSTALLATION (Continued)

HEADLINING (Continued)

Installation

1. Insert headlining into vehicle through liftgate.
2. Position headlining and retain by reinstalling quarter turn fasteners into rear fastener apertures.
3. Reinstall sun visors. Reconnect vanity mirror electrical connector.
4. Install passenger assist handles and screws at upper driver door location.


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5. Install and tighten upper screws of A, B and C pillar trims.
6. Reinstall sliding roof, if so equipped.

SECTION 45-61 INSTRUMENT PANEL PAD

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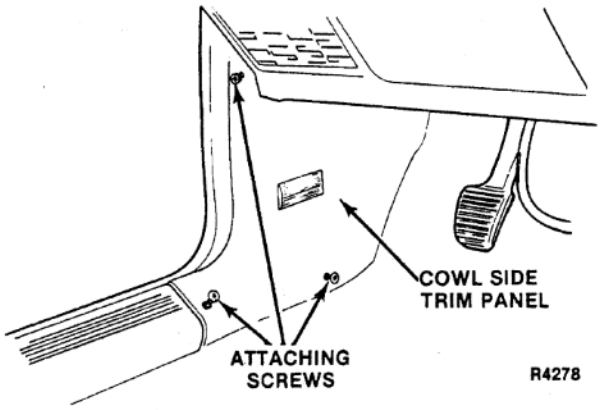
REMOVAL AND INSTALLATION 1

REMOVAL AND INSTALLATION

INSTRUMENT PANEL PAD

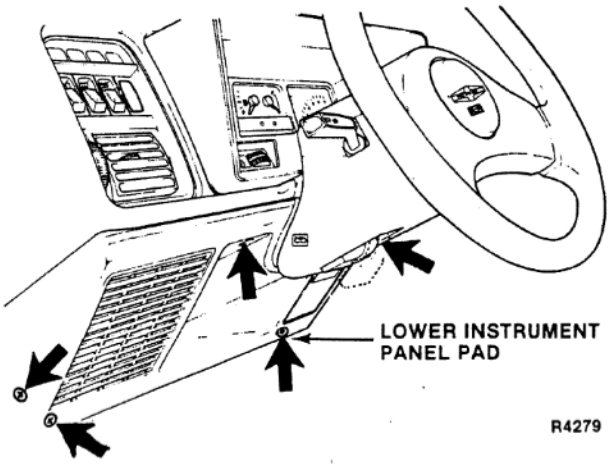
Removal

1. Remove cowl side trim panel attaching screws. Pull the cowl side trim panel away from the body, disconnect the courtesy light wires and remove the panel.



2. Remove upper steering column shroud.
3. Remove lower steering column shroud.

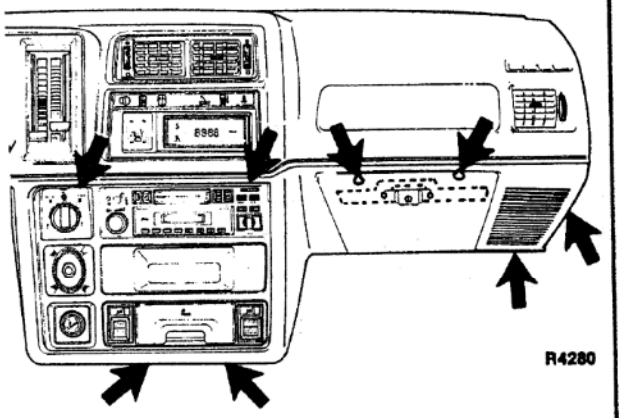
4. Remove five screws and detach driver's side lower instrument panel pad. Disconnect speaker wires and remove driver's side lower instrument panel.



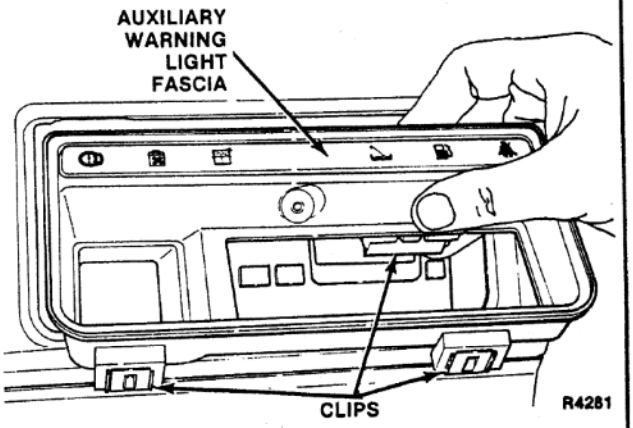
REMOVAL AND INSTALLATION (Continued)

INSTRUMENT PANEL PAD REMOVAL (Continued)

5. Remove center console to allow access to passenger side lower instrument panel pad retaining screws.
6. Pull off the combination fan/air conditioning rotary switch and bezel.
7. Remove eight screws retaining passenger side instrument panel. Disconnect speaker wires, glove box lamp, ash tray lamp, blower switch harness connector, cigarette lighter, and radio connections. Remove passenger side lower instrument panel.



8. Remove instrument cluster bezel and instrument cluster. Refer to Section 33-50.
9. Remove auxiliary warning system fascia and clock/trip computer. Refer to Section 33-92. Remove graphic information module and electrical connector.
10. Remove three screws retaining heater controls to instrument panel pad.
11. Detach auxiliary warning harness connector from pad.



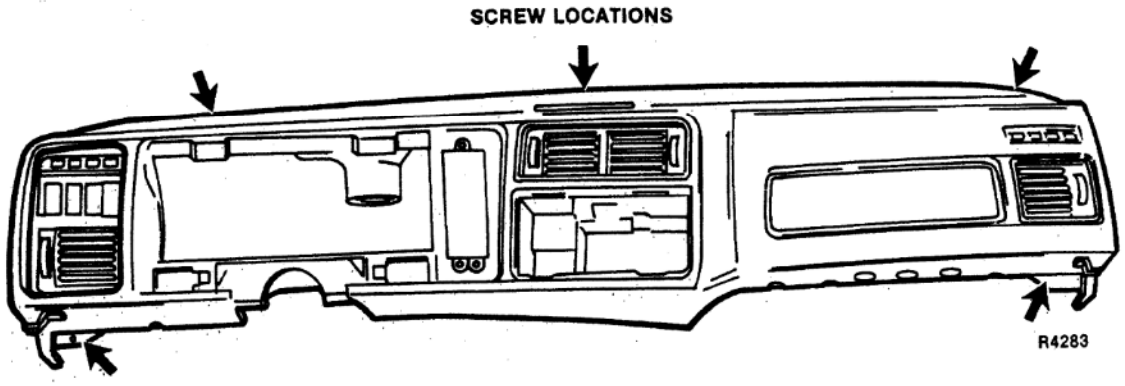
12. Remove fog lamp, and heated rear window switches by prying from the bottom rear wiper/washer of the switch with a flat bladed screwdriver and disconnecting the harness connectors.



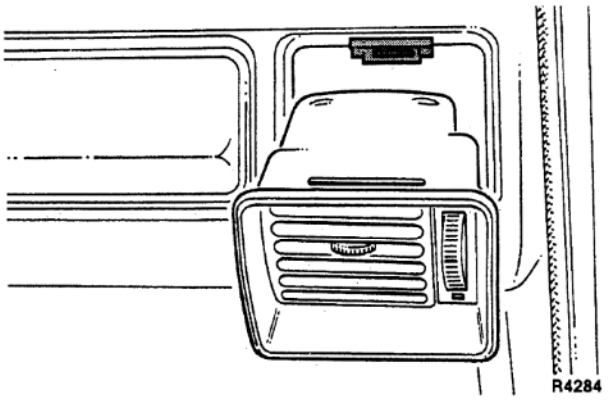
REMOVAL AND INSTALLATION (Continued)

INSTRUMENT PANEL PAD REMOVAL (Continued)

13. Remove five screws retaining upper instrument panel.



14. Detach all heater/air conditioning vent hoses. Remove upper instrument panel.



Installation

Reverse removal procedures.

MOONROOF

GROUP 46 (60000)

TITLE SECTION	PAGE NO.	TITLE SECTION	PAGE NO.

TILT / SLIDE MOONROOF 46-11

DESCRIPTION 2
ADJUSTMENTS 3

REMOVAL AND INSTALLATION
- Tilt/Slide Moonroof 3
- Outer Sliding Roof Panel 5
- Weatherstrip 5

SECTION 46-11 TILT/SLIDE MOONROOF

CONTENTS

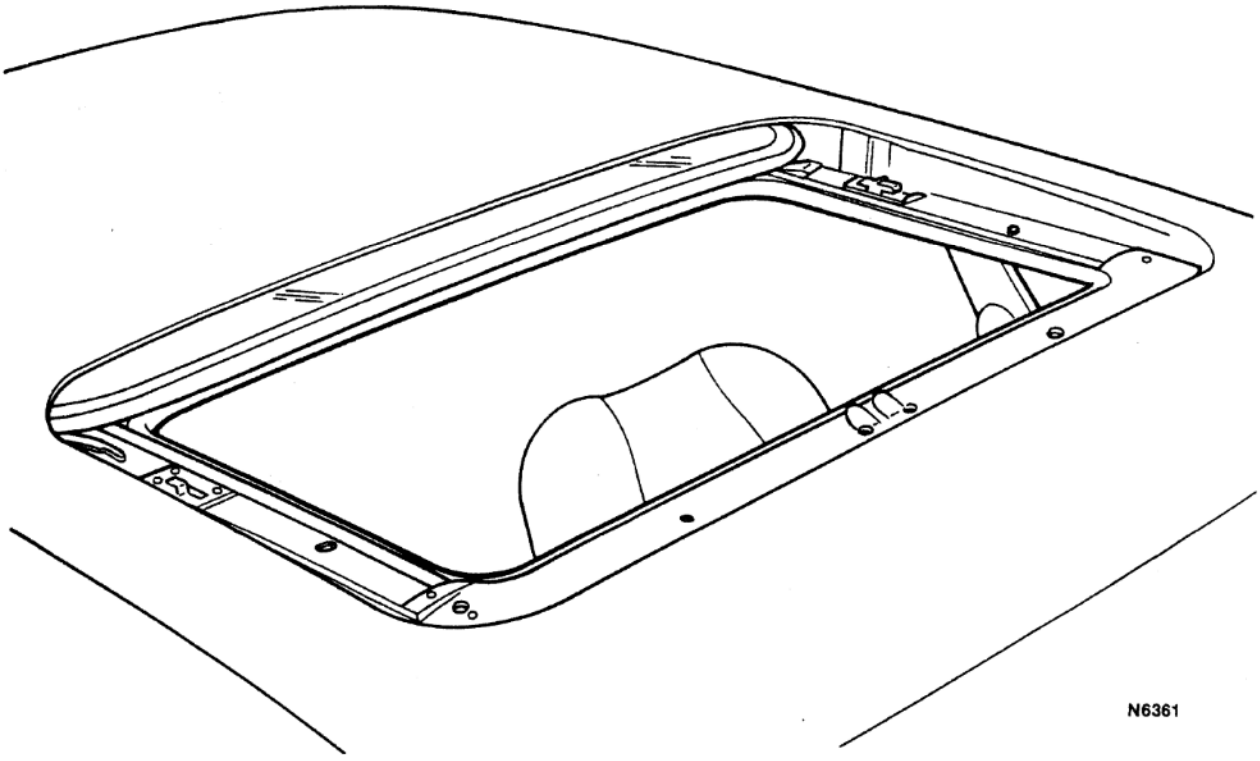
Page

DESCRIPTION 2

ADJUSTMENTS 3

REMOVAL AND INSTALLATION

Tilt/Slide Moonroof 3
Outer Sliding Roof Panel 5
Weatherstrip 5



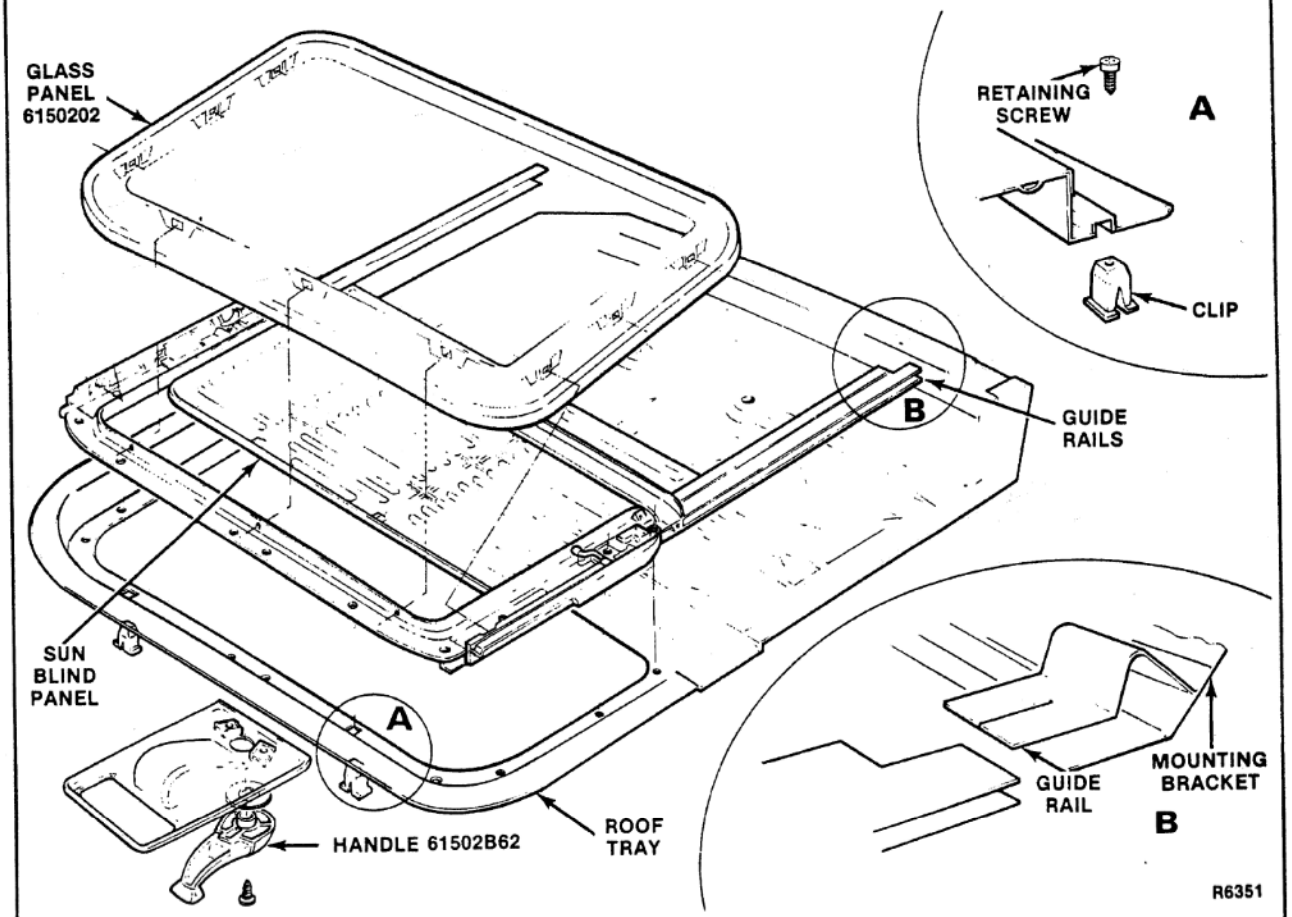
N6361

DESCRIPTION

The tilt/slide moonroof includes both slide and tilt functions. The handle is designed to allow continuous operation between the slide and tilt positions. The handle is splined to a shaft and pinion that drive two flexible cables. Each cable is attached to a slide that moves on the guide rails. The left and right slides are attached by mounting brackets to the rear of the sliding panel. Front guides attached to the front of the sliding panel slide on the left and right guide rails, respectively. The handle is operated by pulling it down from its stowed position and turning counterclockwise to open, and clockwise to close. The back edge of the moonroof may also be tilted upward by cranking the handle one turn clockwise beyond the closed position.

The glass panel itself is made of palladium-coated glass, which allows additional light into the vehicle interior with the moonroof closed, while providing a degree of screening against direct sunlight. A sliding slatted sunblind panel is also fitted immediately below the glass panel to allow the area of roof panel exposed to be adjusted at will. The combined effect of these features gives a high degree of control over interior environment. Drain tubes located in the four corners of the moonroof frame carry surplus water away via the "A" (windshield) pillars and "C" (rear) pillars.

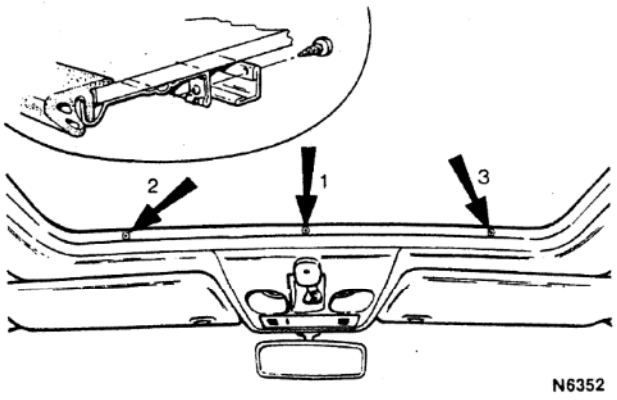
If wind noise and/or waterleaks are to be avoided, it is important that the moonroof be properly adjusted.



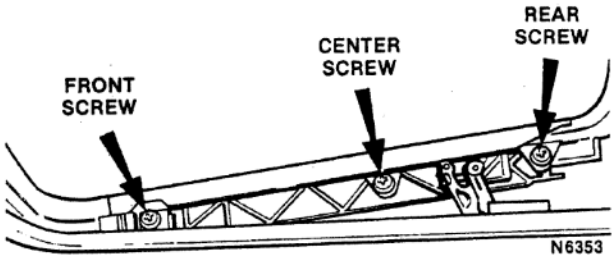
ADJUSTMENTS

NOTE: In all operations involving the removal and installation of the tilt/slide moonroof, be sure to handle the mechanism with care to avoid damage to the surrounding paintwork and trim.

1. Open and close the moonroof from the tilted position. It should not stick or bind during operation. If binding occurs, check the alignment of the moonroof panel relative to the roofline and adjust as follows:
2. Remove the three screws holding the lower frame to the glass. Slide the lower frame into the roof.



3. If the front requires adjustment, loosen the front and center screws. Adjust the height of the moonroof panel flush to 2 mm **below** the roof line and tighten the retaining screws.
4. If the rear requires adjustment, loosen the rear and center retaining screws. Adjust the height of the moonroof panel flush to 2 mm **above** the roof line and tighten the retaining screws.
5. Slide the lower frame forward and install the three retaining screws that hold the lower frame to the glass.

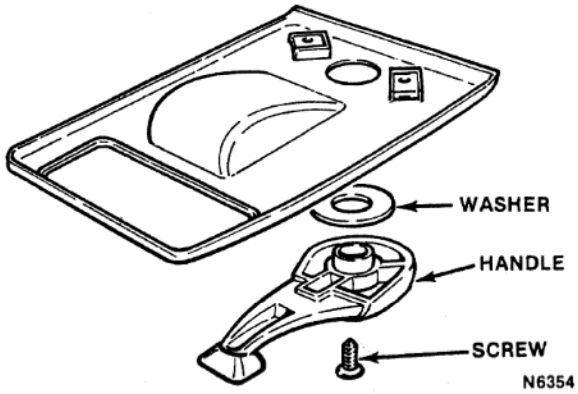


REMOVAL AND INSTALLATION

TILT/SLIDE MOONROOF ASSEMBLY

Removal

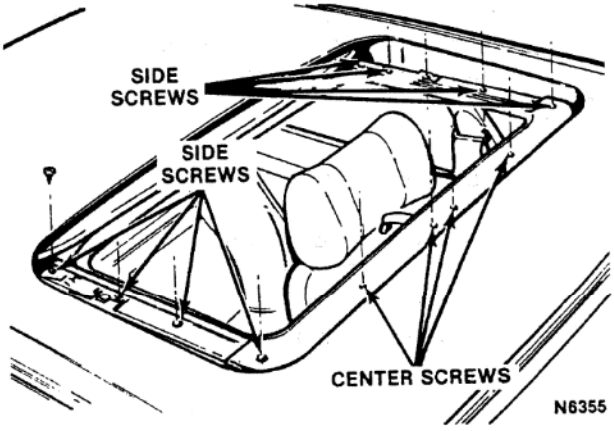
1. Turn the sliding roof handle counterclockwise until the sunroof is entirely open. Remove the screw holding the handle and detach the handle and washer.



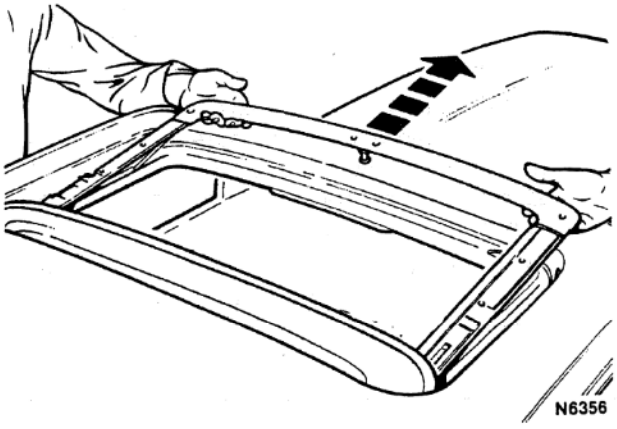
REMOVAL AND INSTALLATION (Continued)

TILT/SLIDE MOONROOF ASSEMBLY REMOVAL (Continued)

2. Remove the four screws on each side and the four screws in the center holding the moonroof gear to the roof tray.

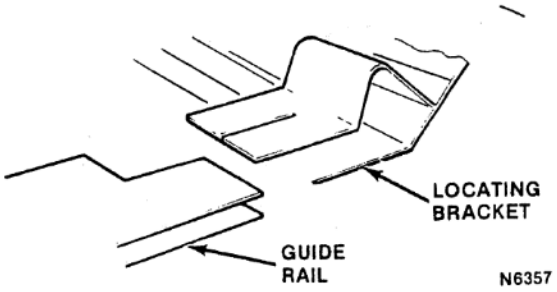


3. Raise the front of the assembly and carefully pull the moonroof assembly from the front of the moonroof opening.



Installation

1. Insert the assembly into the opening in the car roof. Be sure the guide rails are fit into their locating brackets.



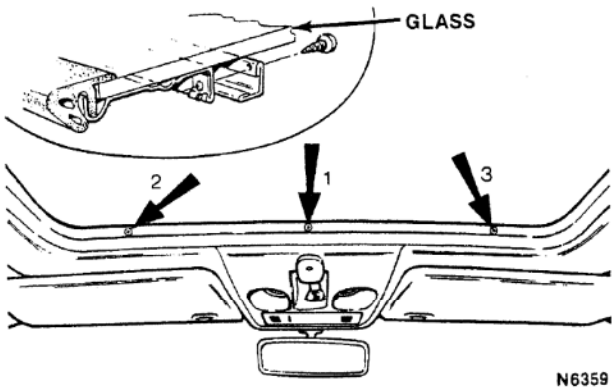
2. Install the four screws on each side and in the center that hold the sliding gear to the tray.
3. Install the handle and adjust the moonroof as necessary.

REMOVAL AND INSTALLATION (Continued)

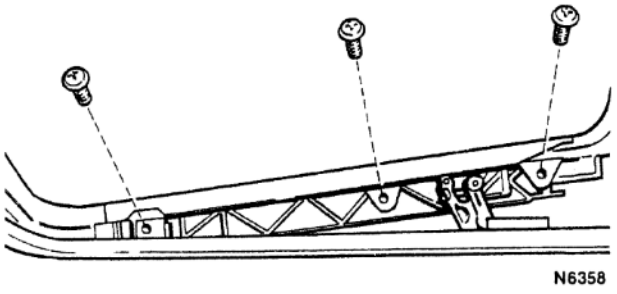
OUTER SLIDING ROOF PANEL

Removal

1. Pull the sunblind into the open position. Remove the three screws connecting the lower frame of the moonroof to glass.



2. Remove the three screws and clips on each side connecting the moonroof gear to glass.
3. Push the glass out to the exterior side of the roof opening.



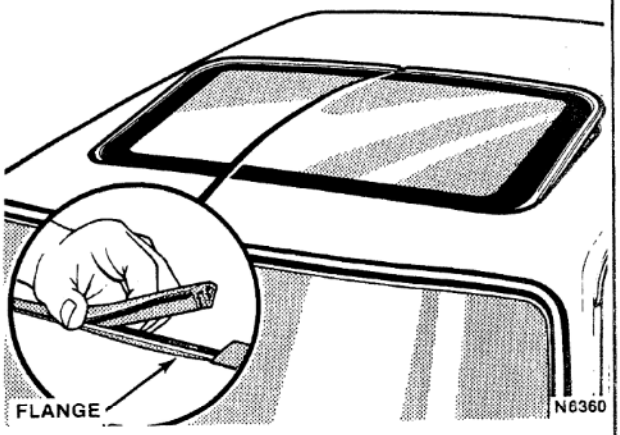
Installation

1. Install the glass into the roof opening. Install the three screws on each side of the roof gear.
2. Adjust the glass as necessary.
3. Insert clips through the brackets on the glass frame; then install the three screws into the clips in the order 1, 2, & 3, as shown.

WEATHERSTRIP

Removal

Pull off the weatherstrip from the flange on the outer edge of the moonroof.



Installation

Install the weatherstrip onto the moonroof flange.

BODY SHELL, EXTERIOR TRIM, FRAME AND UNDERBODY

GROUP 47

(70000)

SECTION 47-10 Body

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Grille Opening Panel	47-10-10
Liftgate Spoiler—1987 and Earlier Models	47-10-7
Liftgate Spoiler—1988 Models	47-10-8
Wheel Lip Moulding	47-10-9

DESCRIPTION

Body Structure

NOTE: For diagnosis of cowl area water leaks, refer to Section 36-01 of this manual.

Construction

- The simplified body construction of the XR4Ti uses about 14 percent HSLA steel and a high percentage of rephosphorized steel. When welding on a Merkur, it is important to be sure to use MIG wire meeting the American Welding Society Standards AWS-E-70S-6.

Door Hinges

- Merkur door hinges are welded to the door and bolted to the body. The service replacement door comes with hinges attached. Hinge pins are a separate service item. Old pins should not be used when replacing the door.

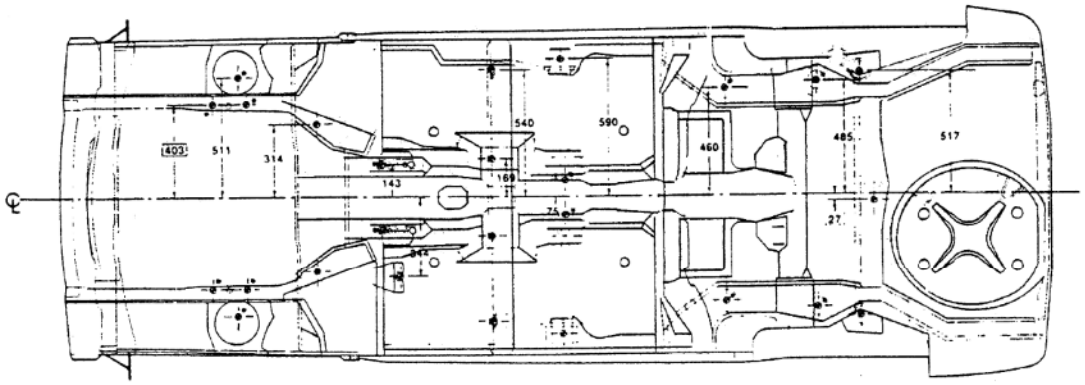
Fenders

- Like other European cars, Merkur's front fenders are welded on.

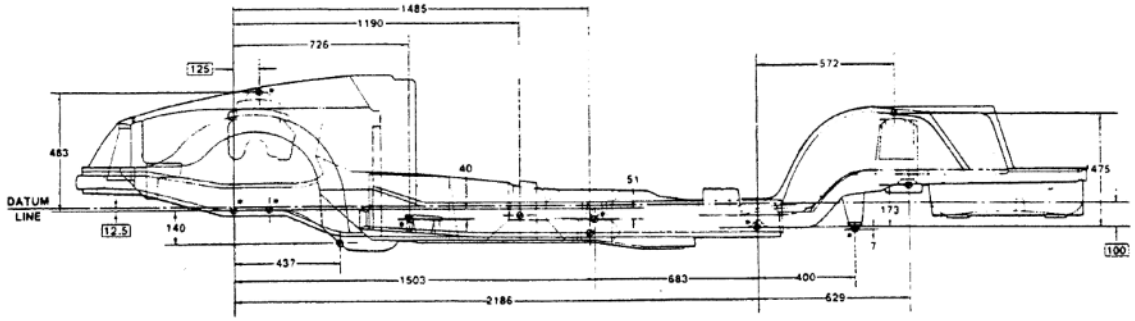
DESCRIPTION (Continued)

Dimensions

TOP VIEW



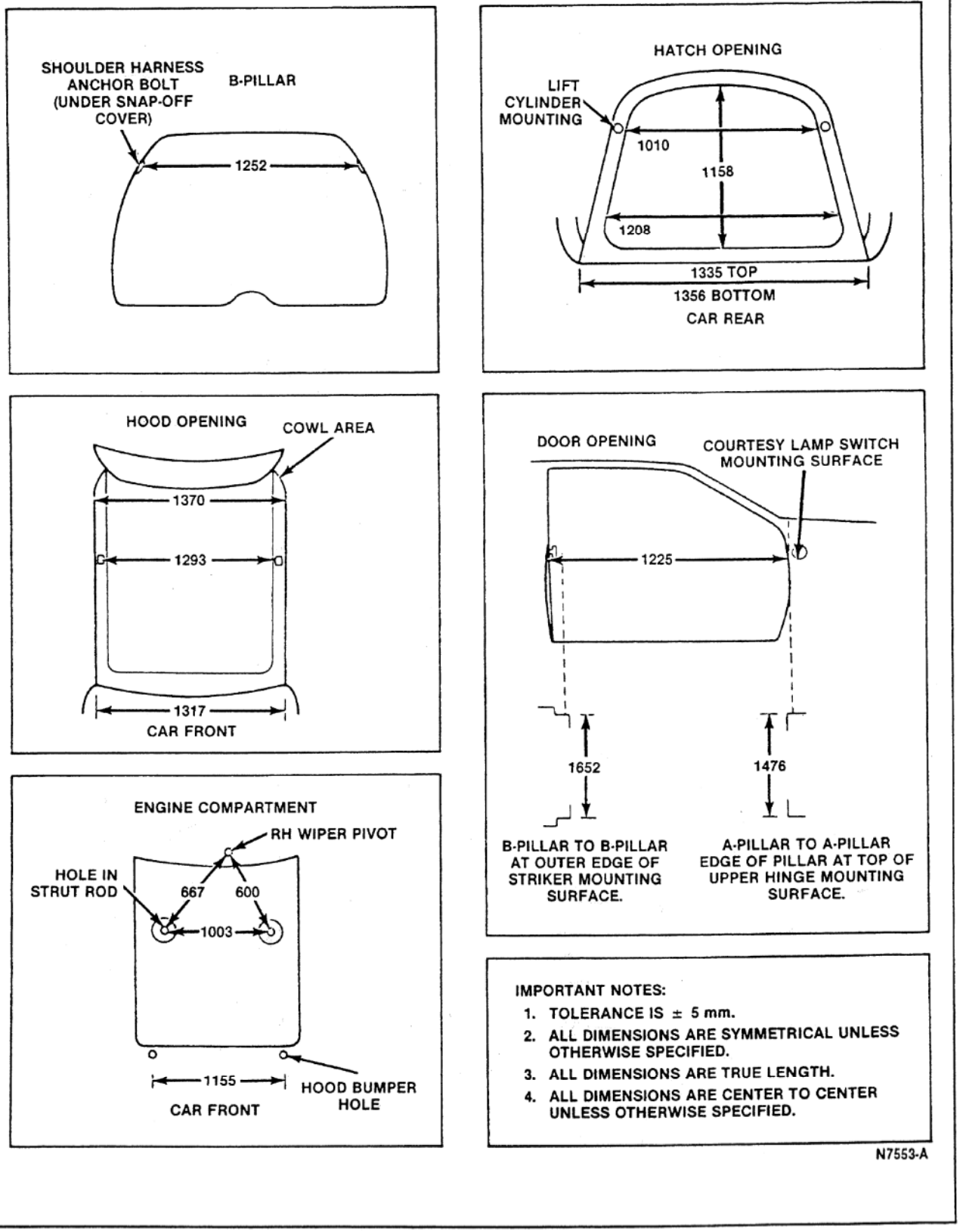
SIDE VIEW



NOTES:
1. ALL DIMENSIONS ARE IN MM.
2. TOLERANCE IS AT ± 3 MM EXCEPT WHERE ☐ IS ± 0 MM.
3. ALL DIMENSIONS ARE X, Y, Z—NOT TRUE LENGTH.
4. SYMMETRICAL DIMENSIONS ARE SHOWN ON ONE SIDE OF C/L ONLY.
5. CORRESPONDING SYMMETRICAL POINTS MARKED * MUST BE SAME HEIGHT WITHIN 3 MM AND EQUAL DISTANCE FORE/AFT WITHIN 3 MM.

N7552-A

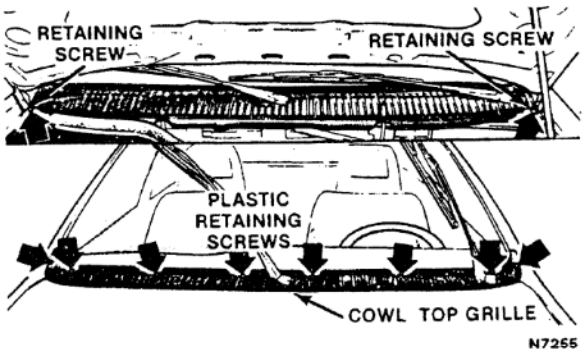
DESCRIPTION (Continued)



DESCRIPTION (Continued)

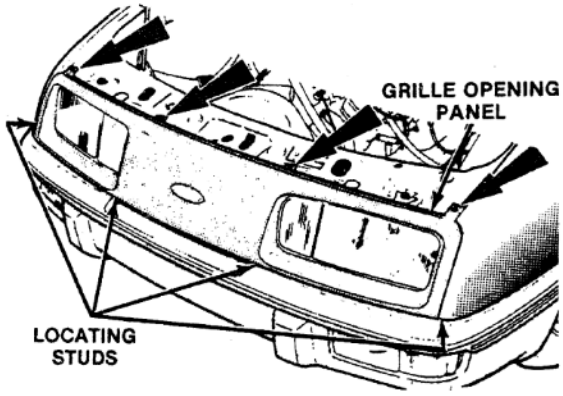
Cowl Top Grille

The vehicle has a detachable cowl top outer grille covering the heater plenum chamber. Removing the panel allows easy access to the lower edge of the windshield.



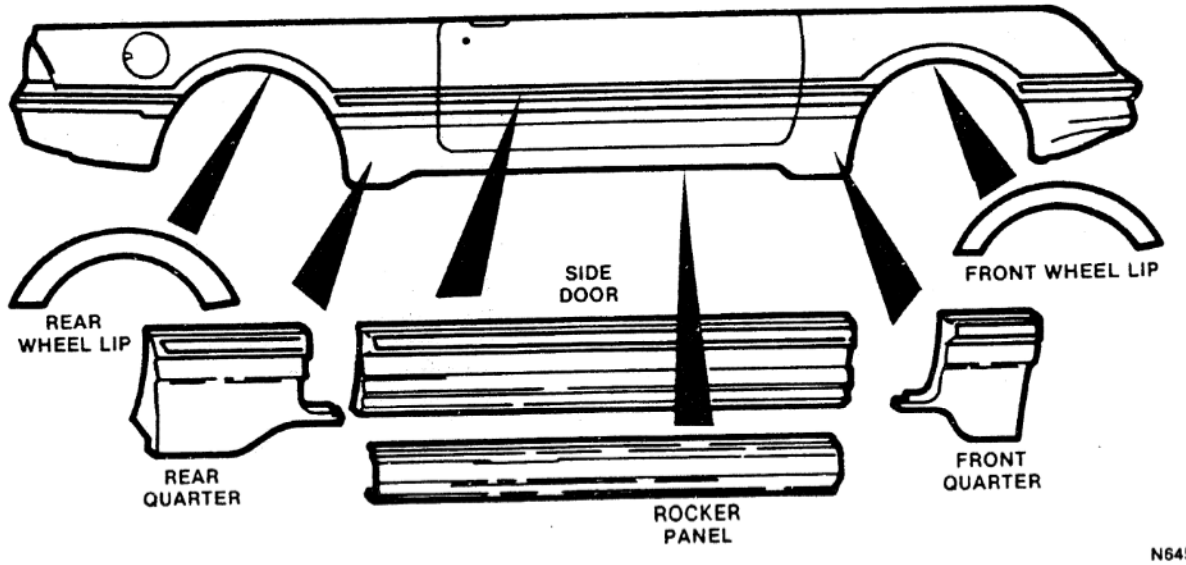
Grille Opening Panel

The grille opening panel encloses the headlamps. It is retained with four screws with star washers and four locating studs.



Bodyside Moulding

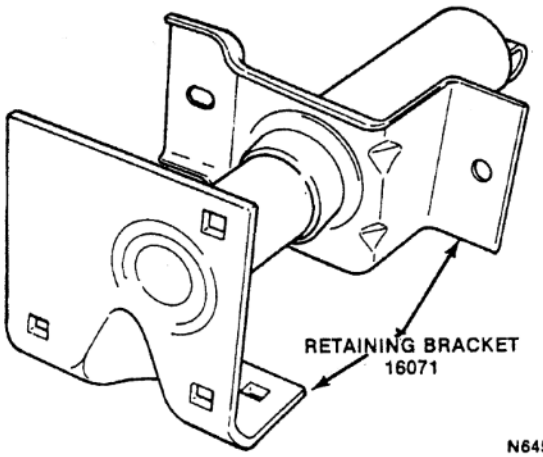
Bodyside mouldings are polycarbonate with contrast finish inserts which cover the retaining rivets. Wheel lip mouldings are made of the same material but are retained with screws instead of rivets.



DESCRIPTION (Continued)

Bumper Assemblies and Bumper Fascias

The vehicle is fitted with high-density polyurethane bumper fascias mounted onto an aluminum bumper bar and attached to the body structure by means of retaining brackets. The bumper is designed to absorb impact energy to minimize body damage in minor impact situations. The bumper fascias are gray-colored with a red insert moulding. The bumper fascias provide an opening on each side for side marker lamps. The front bumper fascia contains fog and turn signal lamps. Bumpers are attached to the body at the wheel opening flange with four attachments at each location.

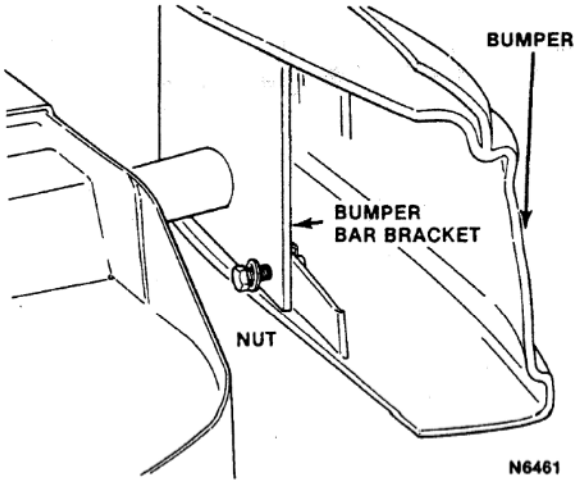


REMOVAL AND INSTALLATION

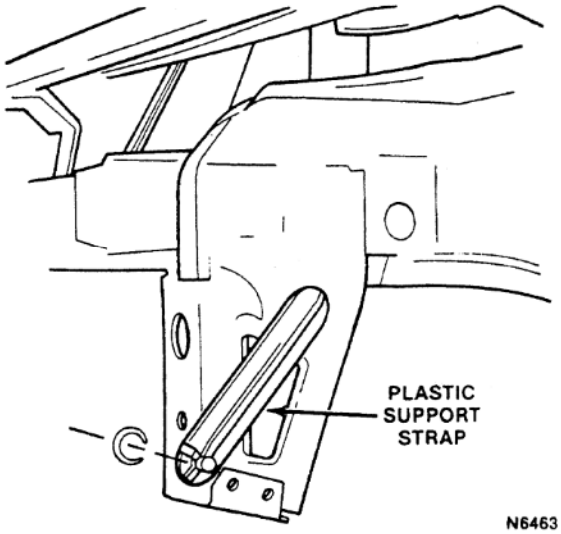
Bumpers

Removal—Front Bumpers

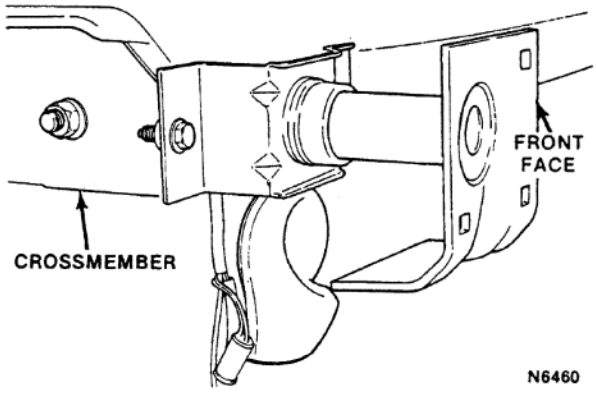
1. Disconnect wiring from fog lamps and turn signal lamps.
2. Remove four nuts at each wheel opening where bumper attaches to bumper bar brackets.



3. Detach the plastic support straps, one on each side, which support the lower side of the fascia.



4. Remove fascia beam from bumper beam by removing front license plate bracket (where applicable) and its three retaining screws. Remove plastic pushpin at center of bumper.
5. Remove four bolts and one nut from bumper arm mounting plate and three screws from fog lamp housing. Remove front bumper beam.
6. To remove mounting bracket, remove two bolts on front face and one bolt running through crossmember.



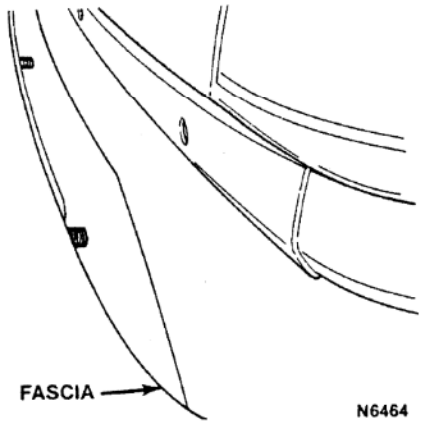
Installation

Reverse removal procedures.

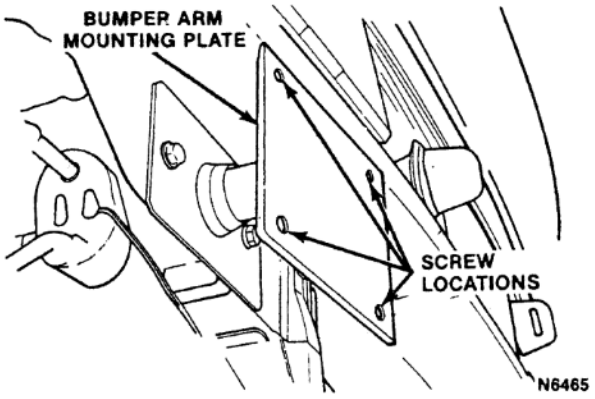
REMOVAL AND INSTALLATION (Continued)

Removal—Rear Bumpers

1. Remove four nuts at each wheel opening where bumper attaches to bumper bar brackets.
2. Open liftgate and remove nuts and washers retaining rear fascia. Detach the fascia from the body along the upper edge by pulling rearward.



3. Pull bumper assembly horizontally away from the body. Take care not to scratch the side marker lamps.
4. Remove four screws from bumper arm mounting plate. Remove rear bumper beam.



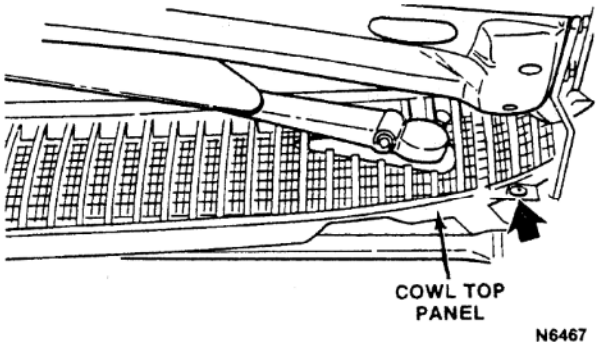
Installation

Reverse removal procedures.

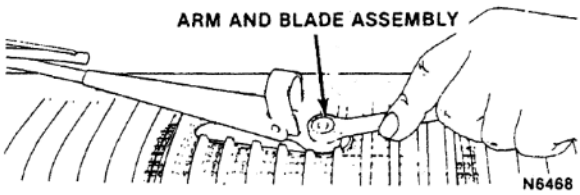
Cowl Top Grille

Removal

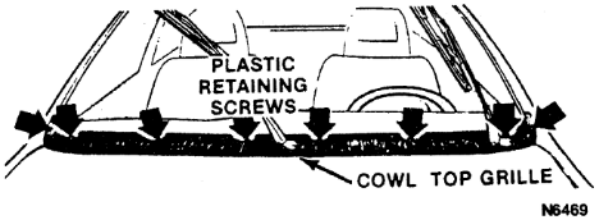
1. Open hood and disconnect washer feed hose. Remove one screw at each end of cowl top panel. Close hood.



2. Remove both windshield arm and blade assemblies.



3. Carefully remove eight plastic screw covers and eight screws retaining cowl top grille to cowl top. Remove cowl top panel.



4. Disconnect the clips connecting center grille to side grille, and the six clips that connect the center grille to the cowl panel.
5. Remove the cowl top center grille together with six plugs.
6. Lift off cowl side grille.

NOTE: Be careful to lift the cowl side grille straight out. Do not turn it while lifting.

Installation

Reverse removal procedures.

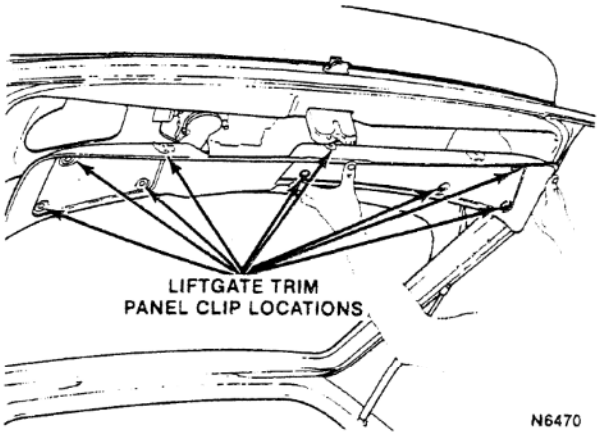
REMOVAL AND INSTALLATION (Continued)

Liftgate Spoiler—1987 and Earlier Models

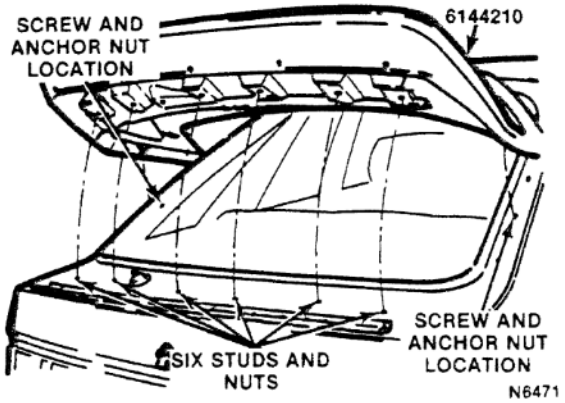
Removal

NOTE: During removal of the liftgate spoiler, nine plastic plugs will be destroyed. New service replacement plugs must be obtained and will have to be painted body color.

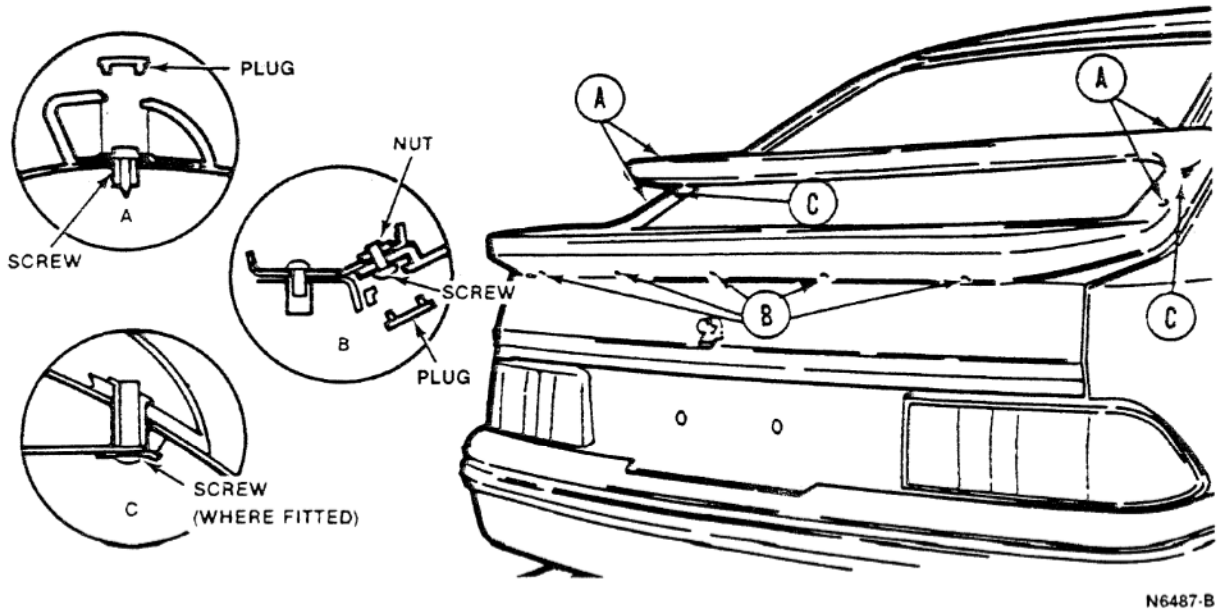
1. Drill out the nine plastic plugs and pull plugs off.
2. Remove the rear windshield wiper arm assembly.
3. Open the liftgate and remove the liftgate trim panel by removing the ten pushpin fasteners.



4. Remove the two screws, located in liftgate pillars, which extend to the anchor nuts in the spoiler.

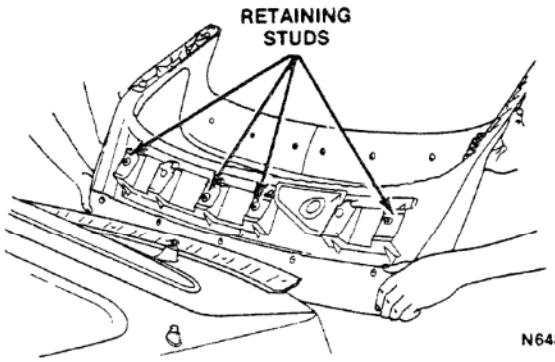


5. Close the liftgate. Remove nine screws securing spoiler.



REMOVAL AND INSTALLATION (Continued)

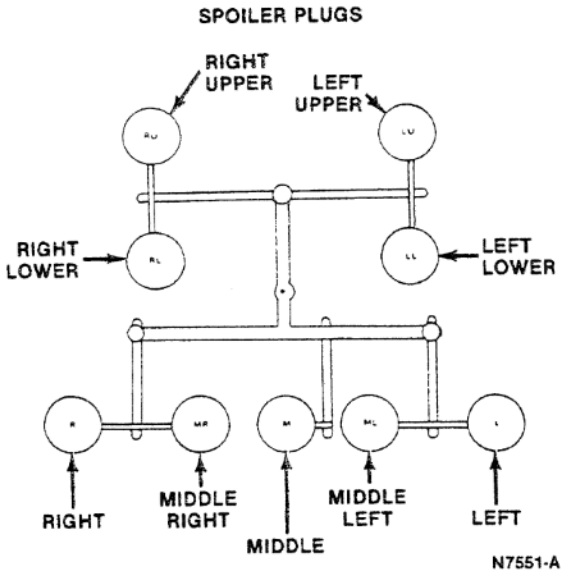
6. Raise the spoiler to clear the retaining studs through the holes in the liftgate and carefully lift the spoiler rearward to clear the mounting bracket. Remove the spoiler.



Installation

1. To install liftgate spoiler, reverse Steps 2 through 6.

NOTE: Service replacement plugs must be painted with appropriate body color prior to installation. Because each of the 9 plugs are specially contoured to fit a specific hole in the spoiler, the plugs are packaged for service on a "tree" as shown. Each plug is embossed on the unfinished side with its designated location.



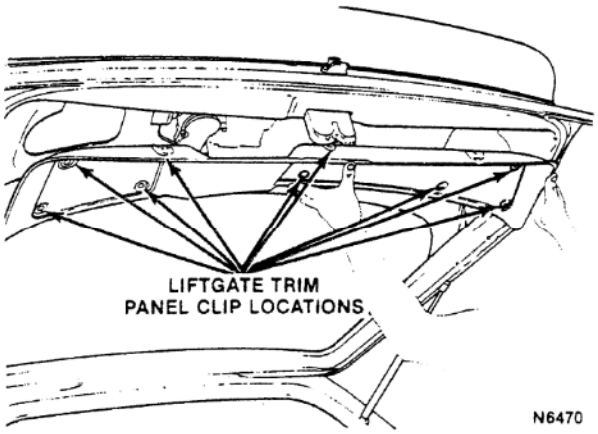
2. Fit new plastic plugs into spoiler.

CAUTION: The plastic plugs fitted to screw "A" are domed to match the contour of the spoiler. Plastic caps fitted to studs "B" are flat. Be sure to fit the caps in the correct locations.

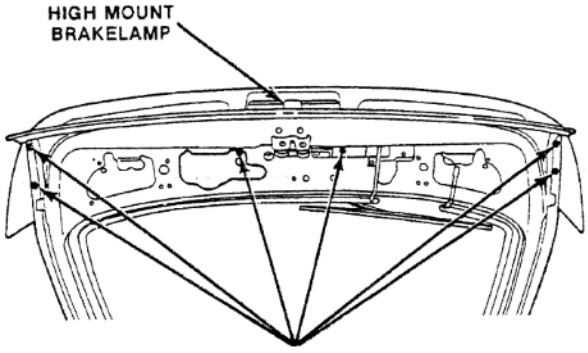
Liftgate Spoiler—1988 Models

Removal

1. Open the lifgate and remove the lifgate trim panel by removing the ten pushpin fasteners.



2. Remove rear wiper arm and motor. Refer to Section 35-60.
3. Remove six nuts from spoiler studs.



4. Carefully close liftgate while holding spoiler in place.
5. Disconnect high mount brakelamp.
6. Remove spoiler. Remove high mount brakelamp from spoiler, if necessary.

Installation

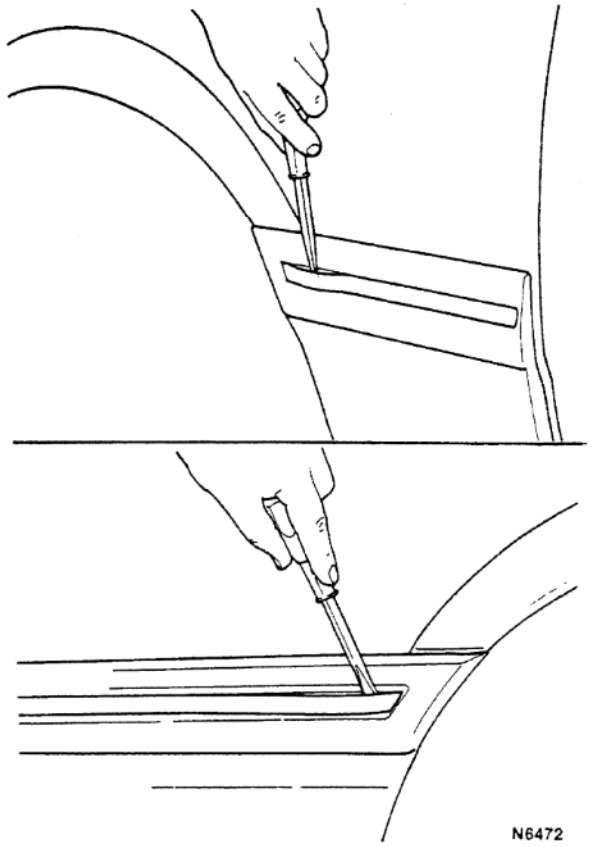
1. Install high mount brakelamp into spoiler, if removed.
2. Connect high mount brakelamp and carefully position spoiler on liftgate.
3. While holding spoiler in position, install six nuts and tighten securely.
4. Install rear wiper arm and motor. Refer to Section 35-60.
5. Install trim panel with ten pushpins.

REMOVAL AND INSTALLATION (Continued)

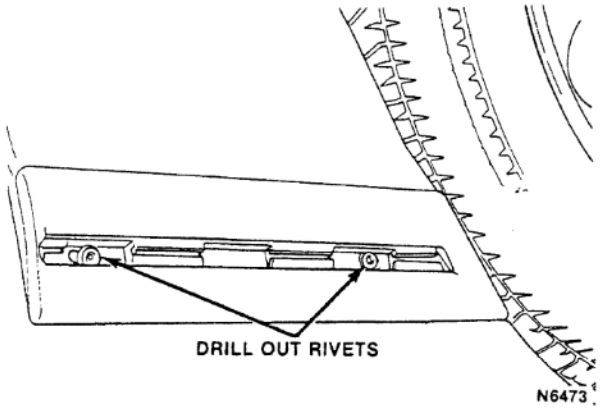
Bodyside Moulding

Removal

1. Using a flat-edged screwdriver, carefully pry out the plastic insert.



2. Drill out rivets and remove moulding.



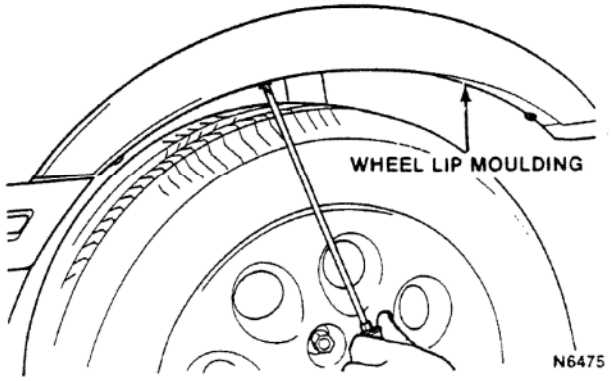
Installation

1. Position bodyside moulding and install rivets.
2. Install plastic insert.

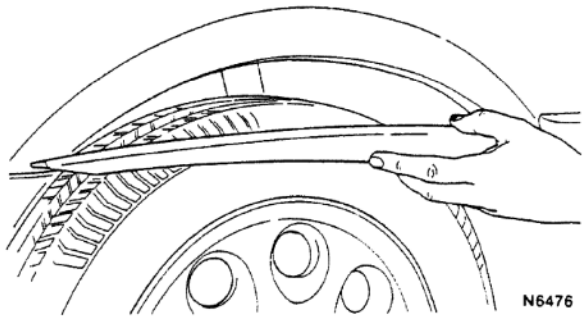
Wheel Lip Moulding

Removal

1. Remove three retaining screws.



2. Lift out moulding.



Installation

Reverse removal procedure.

REMOVAL AND INSTALLATION (Continued)

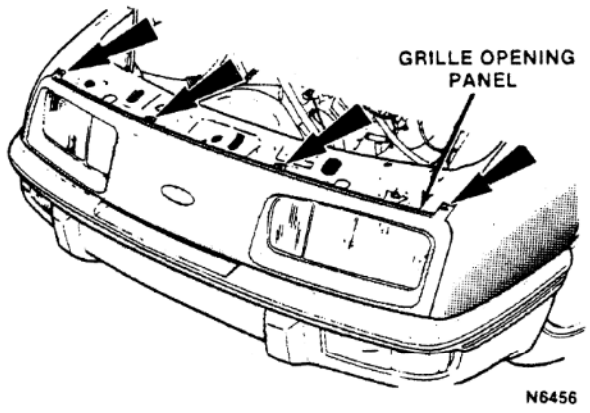
Grille Opening Panel

Removal

1. Remove four screws retaining grille.
2. Lift grille up to disengage four locating lugs and remove assembly.

Installation

1. Position radiator grille assembly on body ensuring locating lugs engage correctly.
2. Install four retaining screws.
3. Ensure that the grille opening panel is correctly installed and aligned when the hood is closed. The grille opening panel should be carefully positioned so that the rubber gap hinder around the headlamp and at the fender is properly aligned.



GROUP

PRE-DELIVERY 50

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PRE-DELIVERY	50-02-1

SECTION 50-02 Pre-Delivery

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Visually Check Engine Coolant Level	50-02-2

UNDERHOOD OPERATIONS

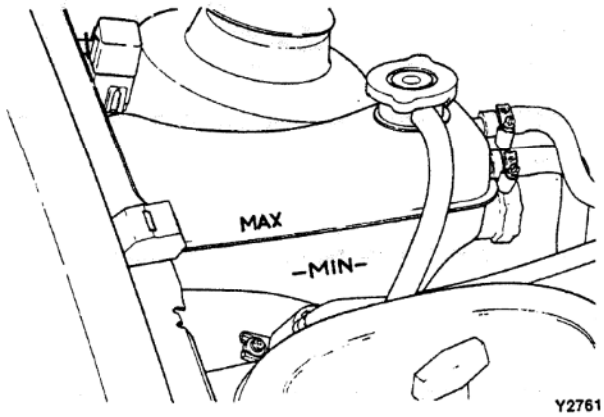
Check Engine Compartment

Visually check engine compartment for overall appearance and for loose, missing, or damaged components.

UNDERHOOD OPERATIONS (Continued)

Visually Check Engine Coolant Level

With a cold engine, the level must be maintained at or above the MIN mark on the coolant expansion reservoir.



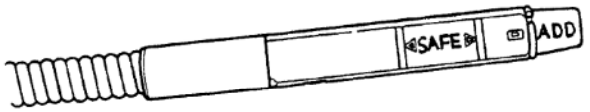
Y2761

At normal engine operating temperature, the coolant level should be at the MAX mark of the coolant expansion reservoir.

If the coolant level in the reservoir is less than the indicated levels, a 50/50 mixture of E2FZ-19549-A (in Canada, Motorcraft CXC-8-B) coolant, or equivalent, and water should be added to the coolant expansion reservoir to the specified levels. If the coolant expansion reservoir is empty, allow engine to cool and add specified 50/50 coolant mixture.

Check Engine Oil Level

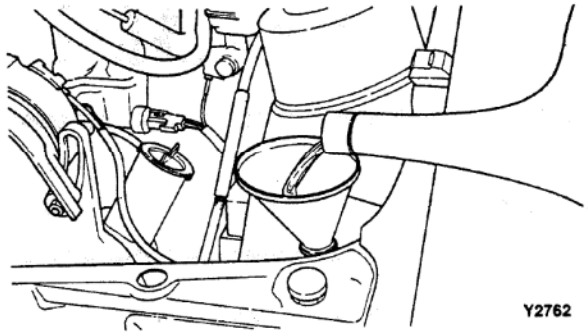
The oil level should be within the SAFE range on the dipstick. Add oil (ESE-M2C153-C and API SF, SF/CC or SF/CD) as required. Assure that the sensor wiring connector is correctly assembled after making the visual check of the dipstick sensor. The sensor is not used for 1987 models.



Y2763

Top-Off Windshield/Liftgate Washer Reservoir

Add fluid such as Ford Ultra-Clear Windshield Washer Solution C9AZ-19550-A, or equivalent, as necessary to top off reservoir.

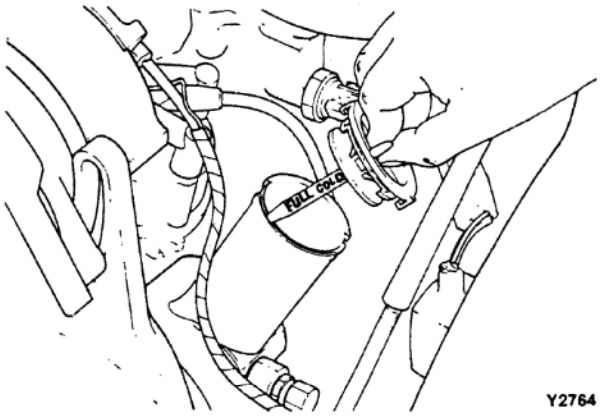


Y2762

Check Power Steering Pump Reservoir Fluid Level—Hot

Run the engine until the fluid is at normal operating temperature, turn the steering wheel all the way to the left and right several times, and shut off the engine. Check the fluid level in the power steering reservoir. The level must show between the FULL COLD and FULL HOT marks when hot. Do not overfill. Remove excess fluid with a suction device.

If the level is low, add power steering fluid, Motorcraft Automatic Transmission and Power Steering Fluid ESW-M2C33-F, to the proper level on the dipstick.

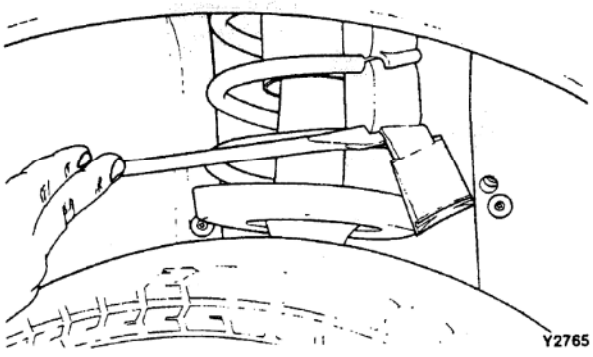


Y2764

CHASSIS OPERATIONS (PERFORM PRIOR TO ROAD TEST)

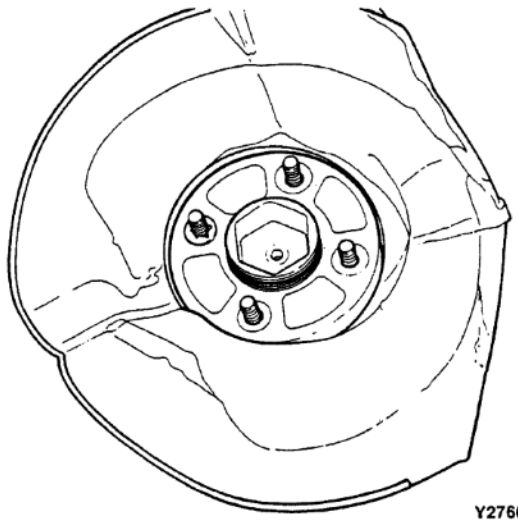
Remove Front Coil Spring Spacers

Raise vehicle so that wheels are off the ground to allow the front coil springs to expand. Remove the coil spring spacers and discard.



Remove Front Disc Brake Shipping Covers

While the vehicle is raised, remove the front disc brake shipping covers and discard.



ROAD TEST OPERATIONS

Set radio preselect buttons to different local stations.

Check operation of radio/cassette player and all controls (including preset buttons and speaker balance control).

Check steering column lock.

Check starting of engine in Neutral (only) for manual transmission and in Park and Neutral for automatic transmission.

Check operation of horn, windshield wiper and washer, (front/rear) lights, signals, hazard flasher and instruments.

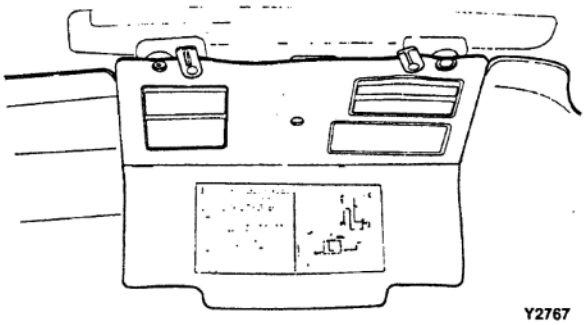
Check throttle operation and idle return.

Check overall system operation including function of all controls of heater, air conditioner, defroster, ventilation system, seat belt warning system, power door lock, and all other optional equipment such as electronic fuel computer and speed control (if equipped).

Check brakes (including parking brake and warning light) and check for brake noise.

Check steering control.

Check driveability during road test (including fast idle return to curb idle during warm-up). If an overt idle speed problem exists, check and ad-on the Vehicle Emission Control Information Decal.



Check automatic transmission performance including initial engagement and shift points, or check manual transmission and clutch.

Check for squeaks, rattles, and unusual noises.

Check for accessory drive belt noise and tighten as required.

Check exhaust system for leaks.

Check steering wheel "clear vision."

APPEARANCE OPERATIONS

Remove Seat and Interior Trim Protectors

Remove seat and interior trim protective covers and make sure that there are no stains or dirt beneath them.

Wash Vehicle

Wash the vehicle completely using warm water. Wipe dry.

APPEARANCE OPERATIONS (Continued)

Check Overall Appearance

Check overall appearance (exterior, interior, hatch area, glove box). Wipe the steering wheel. Make sure no grease or smudges have been left on any controls.

Check Owner Information

Check that the owner portfolio contains the following and is installed in glove box: owner guide, owner card, warranty information booklet, tire warranty booklet, dealership directory.



Y2768

SECTION 50-04 Hoisting, Jacking and Towing

SUBJECT	PAGE
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Drive-On Hoist	50-04-1
Floor Jack	50-04-1
TOWING	
Front Bumper Lifting Procedure	50-04-2

SUBJECT	PAGE
TOWING (Cont'd.)	
Preparatory Steps	50-04-1
Rear Bumper Lifting Procedure	50-04-2
Towing Slings	50-04-1
Towing Speeds	50-04-2

HOISTING INSTRUCTIONS

Damage to suspension, exhaust and/or steering linkage components may occur if care is not taken when positioning the hoist adapters of a two-post hoist prior to lifting the vehicle.

If a two-post hoist is used to lift the vehicle, place the adapters under the front body rail, behind the suspension arm-to-body bracket. Do not allow the adapters to contact the suspension arms, stabilizer bar, or steering linkage.

Refer to the Owner's Guide when using the jack supplied with the vehicle.

Drive-On Hoist

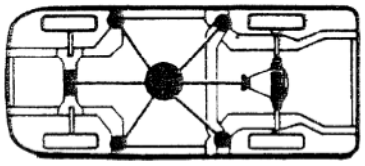
To prevent possible damage to the underbody, do not drive the vehicle onto the drive-on hoist without first checking for possible interference between the upright flanges of the hoist rails and the underbody. If there is interference, modify the hoist flanges as necessary and/or the approach ramps built up to provide the needed clearance.

CAUTION: The service jack, provided with the vehicle, is only intended to be used in an emergency for changing a deflated tire. Never use the service jack to hoist the vehicle for any other service.

Floor Jack

When using a floor jack, raise the front of the vehicle by positioning the floor jack under the front body rail behind the suspension arm-to-body bracket.

Lift the front, as well as either side of the rear end, by positioning the floor jack under the rocker flange at the contact points used for the jack supplied with the vehicle.



• VEHICLE HOIST POINTS

Y2754

TOWING

Preparatory Steps

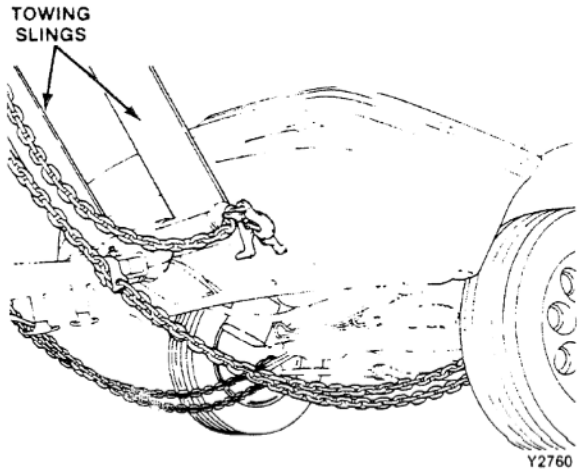
Release the parking brake, and place transmission in Neutral. As a general rule, pull towed vehicles with the driving wheels off the ground. If the driving wheels cannot be raised off the ground, place them on a dolly.

When a vehicle is pulled on its front wheels, clamp the steering wheel in the straight ahead position with a steering wheel clamping device designed for towing service use, such as those provided by towing system manufacturers. Do not use the vehicle's steering column lock to lock the wheels in the straight ahead position when pulled from the rear.

If the ignition key is not available, place a dolly underneath the front wheels of the vehicle and tow with the rear wheels raised.

Towing Slings

To avoid metal-to-metal contact and possible damage to underbody panels, use a special wide-belt sling to lift and tow all vehicles. When attaching towing slings, take care to avoid damage to front license plate and frame (in applicable states).



Y2760

TOWING (Continued)

Towing Speeds

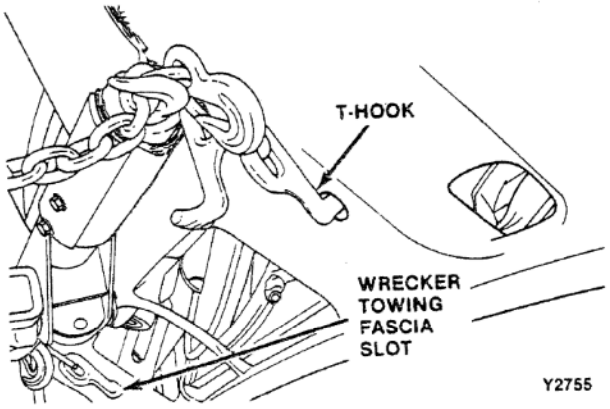
When it is necessary to tow the vehicle with the driving wheels on the ground, do not exceed 56 km/h (35 mph) and/or a distance of 80 km (30 miles) or transmission damage can result.

Limit towing speed to 80 km/h (50 mph) with the driving wheels off the ground. On rough pavement, the maximum towing speed is 56 km/h (35 mph). A maximum towing speed of 56 km/h (35 mph) should be used whenever the tow truck operator is not sure of road surface condition.

Front Bumper Lifting Procedure

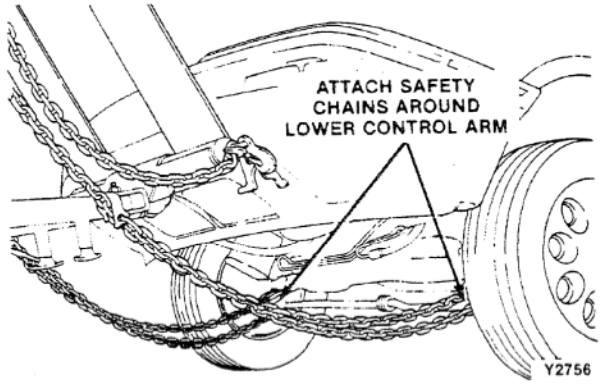
CAUTION: When lifting a vehicle onto a wrecker, the following procedure must be utilized or damage may result to the bumper fascia. Do not use J-hooks under any circumstances.

1. Insert T-hooks in wrecker towing front bumper fascia slots, located on lower front of vehicle.



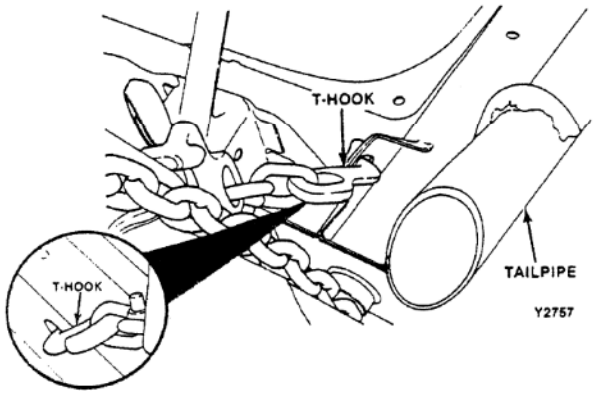
CAUTION: Be sure the T-hook is properly seated through the plastic fascia and metal subframe.

2. Position tow bar directly under bumper.
3. Attach safety chains around lower control arms.

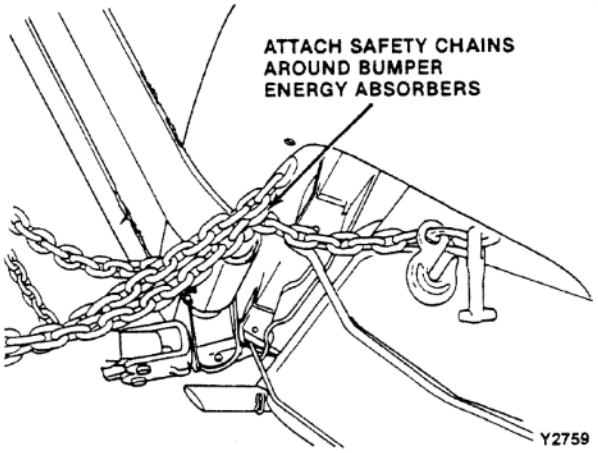


Rear Bumper Lifting Procedure

1. Insert T-hook in wrecker towing slots on frame rail. The driver's side is slotted on the flange of the frame rail next to the tailpipe. The passenger side is located on the side of the frame rail.



2. Position tow bar directly under bumper.
3. Attach safety chains around bumper energy absorbers.

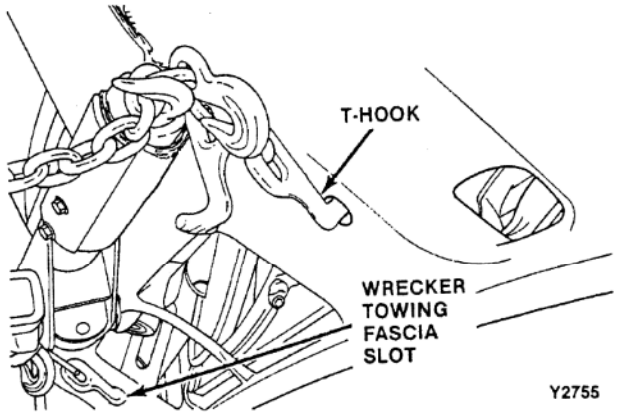


TOWING (Continued)

FRONT BUMPER LIFTING PROCEDURE

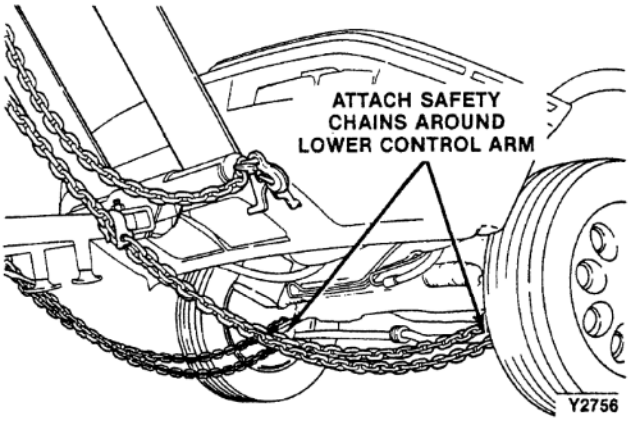
CAUTION: When lifting a vehicle onto a wrecker, the following procedure must be utilized or damage may result to the bumper fascia. Do not use J-hooks under any circumstances.

1. Insert T-hooks in wrecker towing front bumper fascia slots, located on lower front of vehicle.



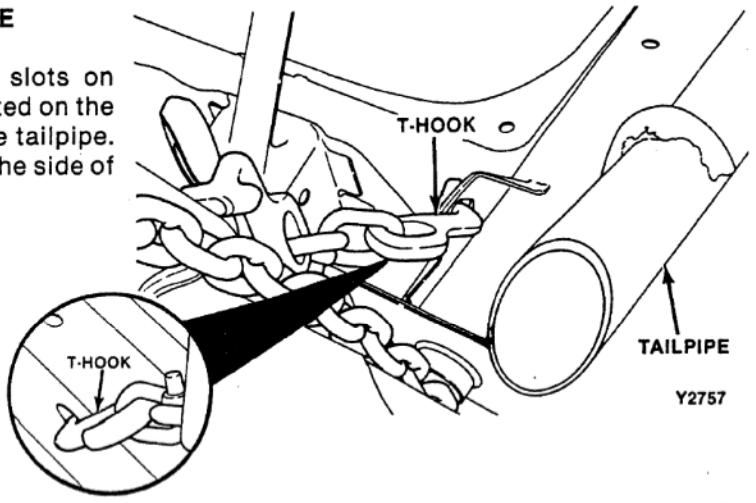
CAUTION: Be sure the T-hook is properly seated through the plastic fascia and metal subframe.

2. Position tow bar directly under bumper.
3. Attach safety chains around lower control arms.



REAR BUMPER LIFTING PROCEDURE

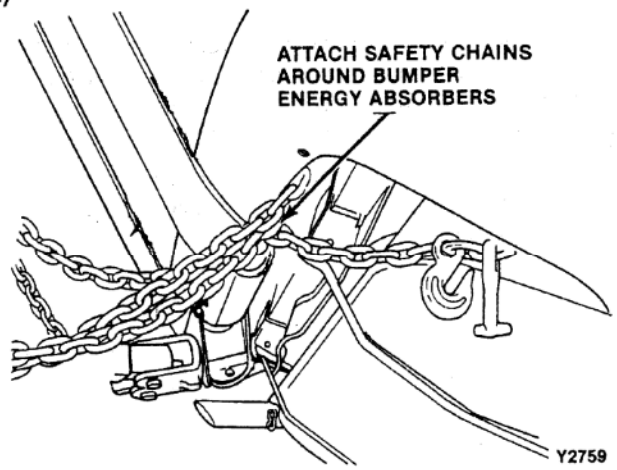
1. Insert T-hook in wrecker towing slots on frame rail. The driver's side is slotted on the flange of the frame rail next to the tailpipe. The passenger side is located on the side of the frame rail.



TOWING (Continued)

REAR BUMPER LIFTING PROCEDURE (Continued)

2. Position tow bar directly under bumper.
3. Attach safety chains around bumper energy absorbers.



ENGINE/EMISSIONS DIAGNOSIS

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GROUP H	SECTION
Emission Control Identification/Application	1
Diagnostic Routines	2
Emission Control Components/Adjustments/Diagnosis	3
Emission Control — EEC Diagnostics	4

SECTION 1

Emission Control Identification/Application

Contents

Vehicle Emission Control Information 1-1

Decal Information and Location 1-2

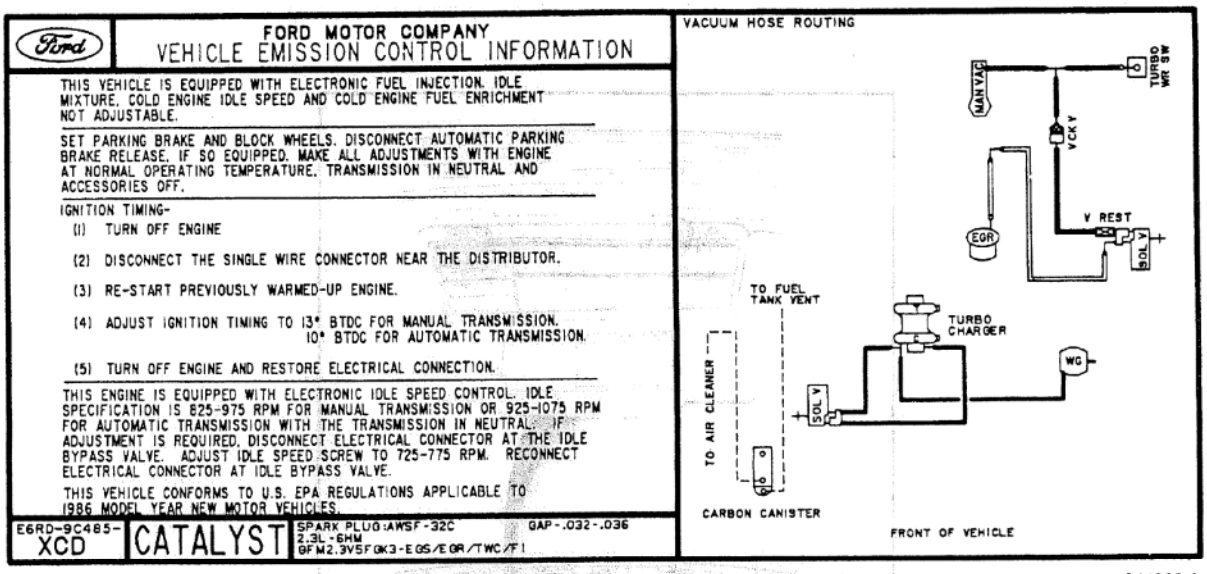
Engine Calibration 1-3

Emission Controls Applications 1-3

Emissions Control Identification/Application

VEHICLE EMISSION CONTROL INFORMATION

Each vehicle is equipped with a decal (Fig. 1) containing emission control data that applies specifically to that vehicle and engine. The specifications provided on the decal are critical to servicing emissions systems.



A11002-A

Figure 1 Merkur XR4Ti Vehicle Emission Control Information Decal

In addition to the tune-up specifications and procedures, the emission decal shows a color coded schematic of the engine vacuum system. The color coding on the schematic represents the actual color coding on the vacuum hoses. However, there will be instances where an individual hose color will not agree.

Emissions Control Identification/Application

DECAL INFORMATION AND LOCATION

Vehicle	Emission Decal	Vacuum Schematic	Location
Merkur XR4Ti 2.3L Turbo	X	X	*Service Information Folder

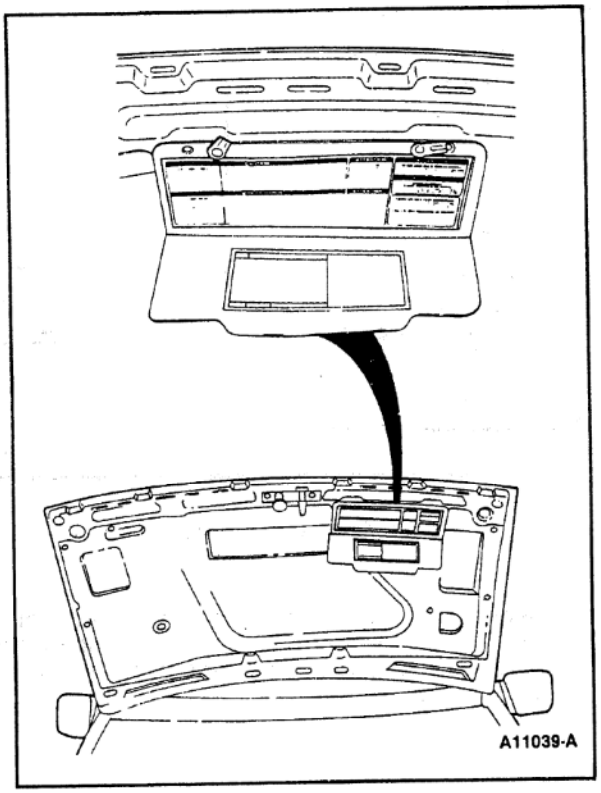


Figure 2 Merkur XR4Ti Service Information Folder

Emissions Control Identification/Application

Engine Calibration

Located on the front of the engine, there is an Engine Code Information Label containing—among other pertinent data—an engine calibration number. (Fig. 3)

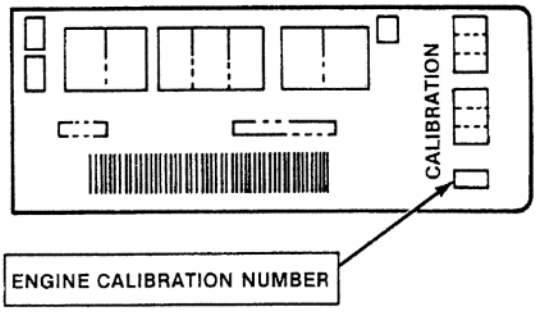


Figure 3 Engine Code Information Label With Engine Calibration Number

EMISSION CONTROLS APPLICATIONS

PASSENGER CAR — 50 STATES/CANADA

Engine	Vehicle Application	Catalyst(s)		Fuel System Type, Mfg	Electronic Eng Ctrl	EGR System	Thermactor System	Ignition System	Idle Speed Control
		Type	Location						
2.3L OHC Turbo	Merkur XR4Ti	TWC	UB	EFI	EEC-IV	Ported	None	TFI-IV	BPA

ABBREVIATIONS:

BPA = Bypass Air
EEC-IV = Electronic Engine Control (System-IV)
EFI = Electronic Fuel Injection
OHC = Overhead Cam
TFI-IV = Thick Film Ignition (System IV)
TWC = Three-Way Catalyst
UB = Underbody

SECTION 2

Diagnostic Routines

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Diagnostic Routines

PREFACE

The Diagnostic Routines lists the components and systems that can contribute to a particular condition in the order of probability, ease of accomplishment, and accessibility. These Routines can be used as check lists for reference in the event of unusual or infrequent causes of malfunction.

It is not necessary that any given order be followed, but it makes good sense for the technician to visually inspect everything that his experience tells him could be the source of the condition before beginning a more involved diagnosis. The effectiveness of every service must be validated.

All references, under the REFERENCE column in each Diagnostic Routine chart, are as follows:

- Group numbers reference a group number shown in the Merkur Shop Manual.
- Section numbers reference a section in the Engine/Emissions Diagnosis Portion of this Manual.
- Special Manual publications are preferenced in some cases.

Diagnostic Routines

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CA5628-B

Diagnostic Routines

201	CRANKS NORMALLY BUT WON'T START	
System	**Component**	**Reference**
Ignition	Electrical Connections Secondary Ignition Wires Ignition Coil Ignition Module Rotor Alignment Distributor Cap, Adapter, Rotor & Stator Spark Plugs Fouled Ignition Switch	Group 23
External Throttle Body	Electrical and Vacuum Connections Throttle Linkages	Group 24
EGR	Valve	H Section 3
Fuel Delivery	Filter Pump Water/Dirt/Rust Contamination in Fuel Lines Tank (Fuel Supply) Sender Filter Inertia Switch	Group 24
EEC	Component Diagnostics	H Section 4
Basic Engine	Camshaft Timing Compression	Group 21

NOTE: Extended cranking, because of a "No Start" condition, can load the exhaust system with raw fuel, which can ruin the catalytic converter after the engine starts. To prevent this, disconnect the EFI injectors, and run engine until surplus fuel is used up before reconnecting.

CA11049-A

Diagnostic Routines

202	STARTS NORMALLY BUT WON'T RUN (STALLS)	
System	**Component**	**Reference**
Throttle Body	Electrical and Vacuum Connections Fast Idle Speed	Group 24
Ignition	Electrical Connections Secondary Ignition Wires Ignition Coil Ignition Module Rotor Alignment Distributor Cap, Adapter, Rotor & Stator Ignition Switch Ballast Resistor	Group 23
EGR	Valve	H Section 3
Fuel Delivery	Filter Pump Water/Dirt/Rust Contamination in Fuel Lines Tank (Fuel Supply) Sender Filter Inertia Switch	Group 24
EEC	Component Diagnostics	H Section 4
Exhaust	Component (Restricted)	Group 26
Basic Engine	Camshaft and Valve Train	Group 21

CA11004-A

Diagnostic Routines

203	CRANKS NORMALLY BUT SLOW TO START	
System	**Component**	**Reference**
NOTE: It is a good practice to confirm that the correct starting procedure was being used by the customer before proceeding with diagnosis.		
Throttle Body	Electrical and Vacuum Connections	Group 24
Fuel Delivery	Filter Pump Water/Dirt/Rust Contamination in Fuel Lines Sender Filter	Group 24
Ignition	Scope Engine for: Spark Plugs, Coil, Secondary Ignition Wires, Distributor Cap, Adapter & Rotor Spark Plugs Fouled	Group 23
Induction and Vacuum Distribution	Vacuum Leaks Air Cleaner Element Restricted	Group 21
Cooling	Electric Fan (Hot Start Only)	Group 27
EGR	Valve	H Section 3
PCV	Valve	H Section 3
EVAP	Components	H Section 3
EEC	Component Diagnostics	H Section 4

CA11005-A

Diagnostic Routines

204	ROUGH IDLE	
System	**Component**	**Reference**
Vacuum Distribution	Vacuum Leaks	Visual, Audible
Throttle Body	Curb or Fast Idle Speeds Electrical and Vacuum Connections	Group 24
Ignition	Scope Engine for: Spark Plug, Coil, Secondary Wires, Distributor Cap, Adapter and Rotor	Group 23
EGR	Valve Vacuum Regulator	H Section 3
PCV	Valve	H Section 3
EVAP	Components	H Section 3
Ignition Timing	Base Plus Advance and Retard Functions	Group 23
EEC	Component Diagnostics	H Section 4
Turbocharger		Group 24
Exhaust	Pipes, Muffler, Catalyst Resonator, Heat Control Valve	Group 26
Basic Engine	Compression Valve Train Camshaft Intake Manifold Gasket	Group 21

CA11006-A

Diagnostic Routines

205	MISSES UNDER LOAD	
System	**Component**	**Reference**
Ignition	Scope Engine for: Spark Plug, Coil, Secondary Wires, Distributor Cap, Adapter and Rotor	Group 23
EEC	Component Diagnostics	H Section 4
Fuel Delivery	Filter Pump Lines Sender Filter	Group 24
Throttle Body	Electrical and Vacuum Connections	Group 24
Ignition Timing	Base Plus Advance and Retard Functions	Group 23

CA11007-A

206	STALLS ON DECEL OR QUICK STOP	
System	**Component**	**Reference**
Throttle Body	Curb or Fast Idle Speed Electrical and Vacuum Connections	Group 24
EGR	Valve	H Section 3
Turbocharger	Retard Switches	Group 24
EEC	Component Diagnostics	H Section 4

CA11008-A

Diagnostic Routines

207	HESITATES OR STALLS ON ACCELERATION	
System	**Component**	**Reference**
Throttle Body	Electrical & Vacuum Connections	Group 24
Induction and Vacuum Distribution	Vacuum Leaks	Visual, Audible
Induction	Air Cleaner Duct and Valve	Group 24
Ignition	Scope Engine for: Spark Plug, Coil, Secondary Wires, Distributor Cap, Adapter and Rotor	Group 23
Throttle Body	Curb or Fast Idle Speeds	Group 24
EGR	Valve	H Section 3
Fuel Delivery	Filter Pump Water/Dirt/Rust Contamination in Fuel Lines Sender Filter	Group 24
EEC	Component Diagnostics	H Section 4
Turbocharger		Group 24
Ignition Timing	Base Plus Advance and Retard Functions	Group 23

CA11009-A

208	BACKFIRE (INDUCTION OR EXHAUST)	
System	**Component**	**Reference**
Vacuum Distribution	Vacuum Leak(s)	Visual, Audible
Ignition	Scope Engine for: Spark Plug, Coil, Secondary Wires, Distributor Cap and Rotor, Crossed Wires	Group 23
Basic Engine	Intake Manifold Gaskets Compression Check Camshaft Valves	Group 21
EEC	Component Diagnostics	H Section 4
Ignition Timing	Base Plus Advance and Retard Functions	Group 23
Exhaust	Components (Restricted)	Group 26
Fuel Delivery	Filter Pump Water, Dirt, Rust, Contamination in Fuel Lines Sender Filter	Group 24

CA11010-A

Diagnostic Routines

209	LACK OF POWER	
System	**Component**	**Reference**
Throttle Body	Electrical and Vacuum Connections	Group 24
Induction	Air Cleaner Duct and Valve and Element	Group 24
Fuel Delivery	Filter Pump Lines Sender Filter	Group 24
EGR	Valve	H Section 3
Basic Engine	Compression Check Camshaft Valves	Group 21
Drivetrain	Clutch, Automatic Transmission Brakes	Groups 12, 15, 16 and 17
EEC	Component Diagnostics	H Section 4
Turbocharger		Group 24
Exhaust	Components (Restricted)	Group 26
Ignition Timing	Base Plus Advance Retard Functions	Group 23

CA11011-A

210	SURGE AT STEADY SPEED	
System	**Component**	**Reference**
Throttle Body	Electrical & Vacuum Connections	Group 24
Vacuum Distribution	Vacuum Leaks	Visual, Audible
Fuel Delivery	Filter Pump Lines Sender Filter	Visual, Group 24
EGR	Valve	H Section 3
EEC	Component Diagnostics	H Section 4
Turbocharger		Group 24
EVAP	Components	H Section 3
Basic Engine	Valve Train and Camshaft Intake Manifold Gaskets	Group 21
Ignition Timing	Base Plus Advance and Retard Functions	Group 23

CA11012-A

Diagnostic Routines

211	ENGINE DIESELS (OR IDLES TOO FAST)	
System	**Component**	**Reference**
Throttle Body	Curb or Fast Idle Speeds Electrical and Vacuum Connections Speed Control Cable	Group 24
Vacuum Distribution	Vacuum Leaks	Visual, Audible
Cooling	Overheating	Routine 218
Idle Speed Control	Components	H Section 3 & 4
Induction	Vacuum Leaks	Group 24

If engine idles smoothly after being shut off, trouble is likely to be in the ignition switch, ignition harness, starter solenoid "IGN" tap, or EEC relay.

CA11013-A

212	ENGINE NOISE	
Symptom	**Component**	**Reference**
Squeal, Click or Chirp	Oil Level (Low) Valve Train Drive Belts (Loose) Belt Driven Components EEC Solenoids	Visual, Audible, Group 21 and Group 27
Rumble, Grind	Belt Driven Components	
Rattle	Component (Loose)	
Hiss	Vacuum Distribution System (Leak) Induction System (Leak) Spark Plug (Loose)	Visual, Audible and Group 21
	Cooling System (Leak)	Visual and Audible
	EVAP System (Leak)	H Section 3
Snap	Secondary Ignition	Visual and Audible
Rap, Roar	Exhaust System (Leak)	Visual, Audible, Group 26
Whine	Turbocharger (Some Whine Is Normal)	Audible
Knock	Connection Rod Bearing (Worn) Main Bearing (Worn) Piston Pin (Loose) Piston to Bore Clearance (Cold Engine)	Group 21
	Fuel Pump	Group 24
	Detonation	Routine 215

CA11014-A

Diagnostic Routines

213	POOR FUEL ECONOMY	
System	**Component**	**Reference**
While fuel consumption is drastically increased for short-run operation, stop and go driving, trailer towing, extended winter warm-up periods, etc., as opposed to "trip" mileage, an attempt should be made to determine these factors when confronted with "poor mileage" conditions. However, since the operator is not always at fault, the following is appended:		
Throttle Body	Electrical & Vacuum Connections	Group 24
Induction	Air Cleaner Element (Restricted)	Group 24
Ignition	Scope Engine for: Spark Plug, Coil, Secondary Wires, Distributor Cap, Adapter and Rotor	Group 23
EEC	Component Diagnostics	H Section 4
Fuel Delivery	Fuel Return Line Blocked	Group 24
Cooling	Thermostat	Group 27
Factors External to the Engine	Tire Pressure & Type Clutch Operation Automatic Transmission Shift Pattern and Fluid Level Brake Drag Exhaust System Speedometer/Odometer Gear Ratio Axle Ratio Vehicle Load Road & Weather Conditions	Manual and Visual
Ignition Timing	Base Plus Advance and Retard Functions	Group 23

CA11015-A

214	HIGH OIL CONSUMPTION	
System	**Component**	**Reference**
External Leaks		Visual
Proper Dipstick	Overfilling (Sometimes Accomplished by the "Short Stick" Gas Station Procedure)	Manual and Visual
Induction	Air Cleaner Element (Sealing)	Visual and Group 24
PCV	Valve	H Section 3
Turbocharger	Compressor/Turbine Bearing, Seals, Center Drain, Etc.	Visual and Group 24
Internal Leaks (Blue Smoke From Tailpipe)	Valve Guides Valve Stem Seals Intake Manifold and Gasket Cylinder Head Drain Passages Piston Rings	Group 21

If the condition cannot be verified, clean engine, if necessary, change oil and filter (at customer's expense), seal and have customer drive 804.5 Km (500 miles) or enough distance to consume two quarts before returning for re-examination.

Diagnostic Routines

215	SPARK KNOCK/PINGING	
System	**Component**	**Reference**
EGR	Verify Correct Application, Then Diagnose	H Section 3
Vacuum Distribution	Vacuum Leaks	Visual, Audible
Basic Engine	Oil Level Compression Check Intake Manifold Gasket	Group 21
Cooling	Overheating	Routine 218
EEC	Component Diagnostics	H Section 4
Turbocharger		Group 24
Ignition Timing	Initial Plus Advance and Retard Functions	Group 23

If the above fails to correct the condition, it is recommended that the owner change his source of fuel and use higher octane fuel.

CA11017-A

216	ENGINE VIBRATES AT NORMAL SPEEDS	
System	**Component**	**Reference**
Engine Accessories	Belt Driven Components Engine Mounts Engine Vibration Damper	Manual and Visual
Otherwise	Non-Engine Components: Drive Line, Tires, Wheel Balance	Manual and Visual

CA6348-B

217	ENGINE RUNS COLD	
System	**Component**	**Reference**
Gauge System	Gauge, Sender	Group 33
Cooling	Thermostat	Group 27

CA6349-B

Diagnostic Routines

218	ENGINE RUNS HOT	
System	**Component**	**Reference**
Cooling	Coolant Level Radiator or A/C Condenser Pressure Cap and Overflow System External Leaks Belts and Belt Tension Electric Fan	Visual, Group 27
Gauge System	Gauge, Sender	Group 33
Cooling	Thermostat	Group 27
Ignition Timing	Base Plus Advance and Retard Functions	Group 23
EEC	Component Diagnostics	H Section 4
Basic Engine	Oil Level Internal Leak(s) Core Sand in Head/Block Water Pump	Group 21
Brake	Brakes (Dragging)	Group 12

CA11020-A

219	EXHAUST SMOKE	
Symptom	**Component**	**Reference**
Black Smoke (Rich Mixture)	Air Cleaner Element (Restricted)	Visual
	EEC Components	H Section 4
Blue Smoke (Burning Oil)	PCV Valve	H Section 3
	Valve Guides/Stems/Seals Oil Drain Passages in Head	Group 21
	Turbo Bearing Seals	Group 24
	Rings (Not Seated) Cylinder Bores (Scuffed)	Group 21
White Smoke (Coolant in Combustion)	Intake Manifold Cylinder Head/Gasket (Leaks) Block (Cracked/Porous)	Group 21

NOTE: White smoke is normal during warm-up.

CA11021-A

Diagnostic Routines

220	GAS SMELL	
System	**Component**	**Reference**
Fuel Delivery	Fuel Filter (Leaks) Fuel Line to Injectors (Leaks) Fuel Pump (Leaks) Fuel Line, Pump to Tank (Leaks) Fuel Tank (Leaks) Fuel Tank Filler Neck/Cap (Leaks) Fuel Return Line (Blocked)	Visual Section 11 and Group 24
EVAP	Component (Leaks)	H Section 3

CA11022-A

SECTION 3

Emission Control Components/Adjustment/Diagnosis

Contents

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Vane Air Flow Meter	12B529	3-31

Section 3 provides descriptions of emission control components and in some cases provides information concerning adjustment and diagnosis.

TITLE	BASIC PART NO.	SYMBOL
Air Bypass Valve	**9F715**	

DESCRIPTION

The air bypass solenoid is used to control engine idle speed and is operated by the Electronic Engine Control EEC module.

The valve allows air to pass around the throttle plates to control:

- Cold engine fast idle.
- No touch start.
- Dashpot.
- Over temperature idle boost.
- Engine idle load correction.

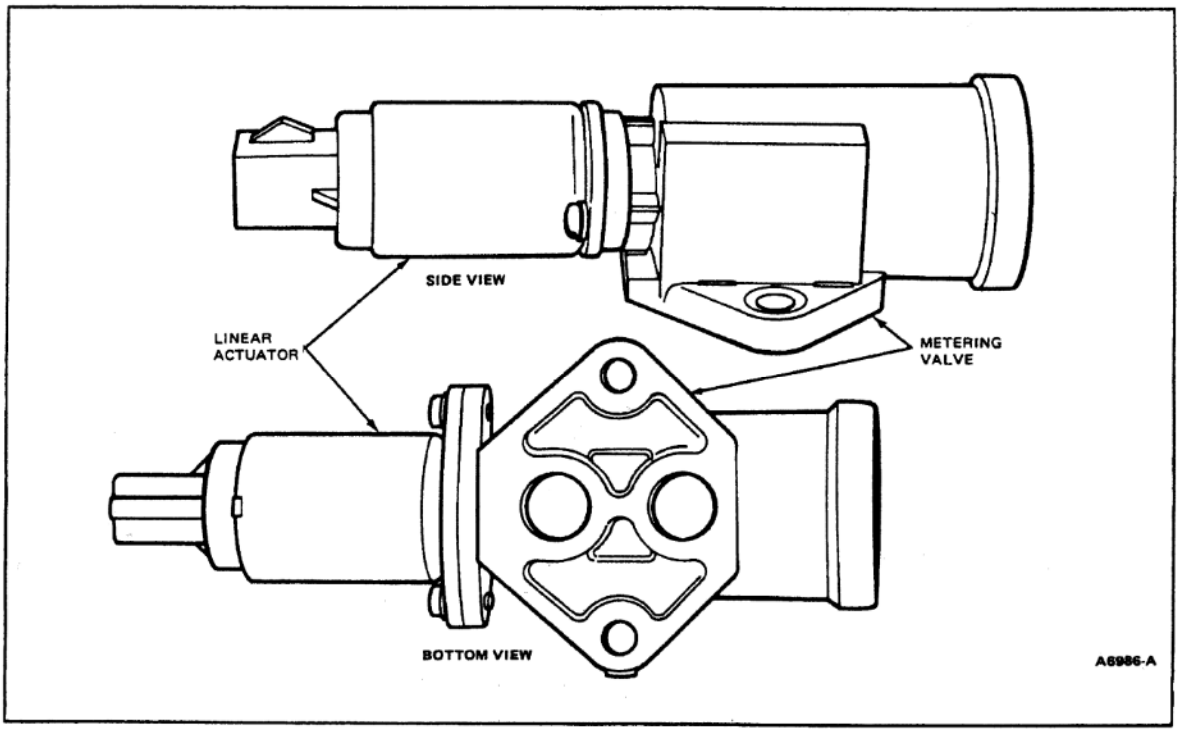


Figure 1 Air Bypass Valve Assembly

DIAGNOSIS

The signal to the solenoid should be 1 volt or less at curb idle, (with all accessory loads off).

Applying 12 volts to the solenoid will cause a Neutral idle speed change greater than 1,000 rpm.

For complete Diagnosis, refer to EEC Diagnosis, Section 4.

TITLE	BASIC PART NO.	SYMBOL
Air Throttle Body Assembly	**9E926**	

DESCRIPTION

The Throttle Body Assembly, (Figure 1) controls airflow to the engine via a single or dual butterfly valve. The throttle position is controlled by conventional linkage. The body is a single-piece, die casting of aluminum. It has a single bore with an air bypass channel around the throttle plate.

Other features of the air throttle body assembly include:

1. an adjustment screw to set the throttle plate at a minimum idle airflow position,
2. a pre-set stop to locate the wide-open-throttle (WOT) position,
3. a throttle body mounted throttle position sensor,
4. idle air bypass valve.

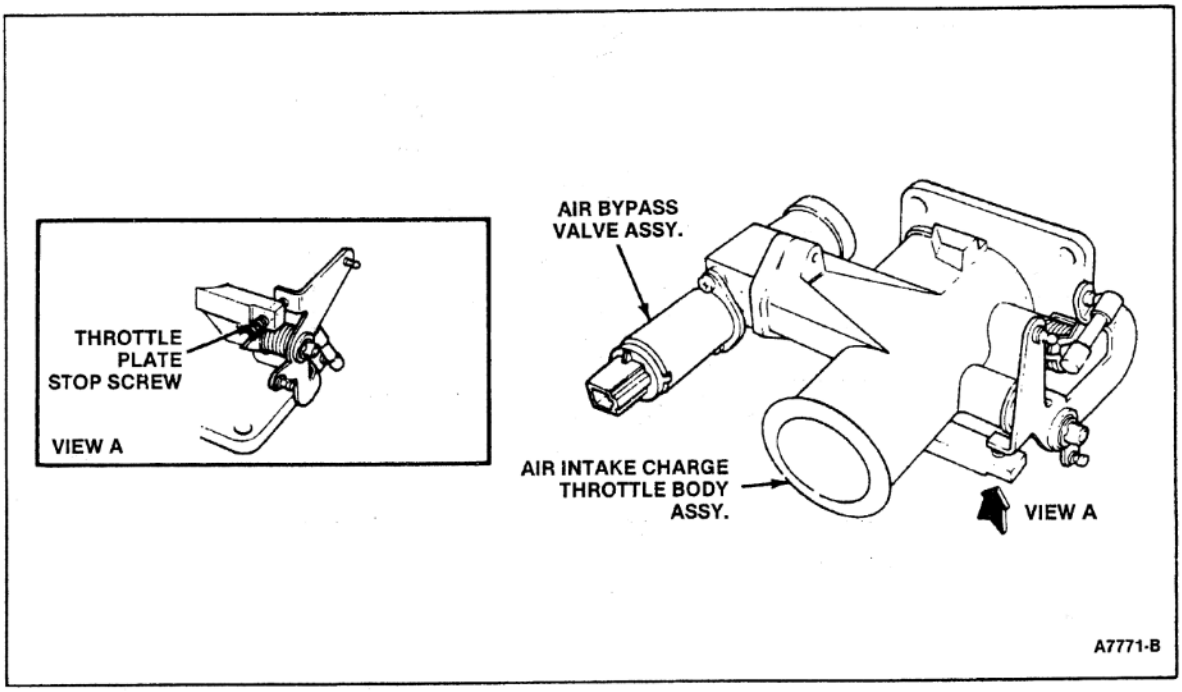


Figure 1 2.3L Turbo w/Electronic Fuel Injection

Idle Speed Setting Procedures

2.3L EFI Turbo

Instructions

This procedure is to be performed only if the curb idle is not within 900 ± 75 RPM (Manual Trans.) or 1000 ± 75 RPM (Automatic Trans.).

NOTE: Curb idle speed (RPM) is controlled by the EEC-IV processor and the idle speed control air bypass valve assembly (Fig. 1). If engine curb idle rpm is not within specification after performing this procedure, it will be necessary to perform the appropriate 2.3L EFI Turbo EEC-IV diagnostics.

1. Place the transmission in neutral, turn the A/C-Heat selector to the Off position.
2. Bring the engine to normal operating temperature and turn Off.
3. Disconnect the idle speed control air bypass valve power lead.
4. Start engine and operate at 2,000 rpm for 120 seconds.
5. If electric cooling fan comes on during idle speed set procedure, wait for the fan to turn off before proceeding.
6. Let engine idle and check base idle rpm (750 ± 25 rpm).
7. Adjust engine rpm to specification by adjusting throttle plate stop screw (Fig. 1).
8. Shut engine off and reconnect.
   - Power lead to idle speed control air bypass valve.
   - Electric cooling fan.
9. Verify throttle plate is not stuck in the bore by exercising throttle plate.

NOTE: If excessive engine idle speeds are experienced when driving the vehicle on the idle system, turn the ignition switch to Off position and restart.

TITLE	BASIC PART NO.	SYMBOL
Barometric Pressure Sensor	**12A644**	

DESCRIPTION

The Barometric Pressure (BP) sensor (Figure 1) operates as a piezoelectric disc capacitor, except that the output signal has its frequency changed rather than voltage. The BP sensor is used to sense changes in barometric pressure, allowing the ECA to sense the altitude at which the vehicle is operating. The frequency range of this sensor is 122-162 Hz. The primary systems affected by the BP sensor are the air/fuel ratio and EGR flow due to altitude compensation. It is located on the right fender well (Figure 2).

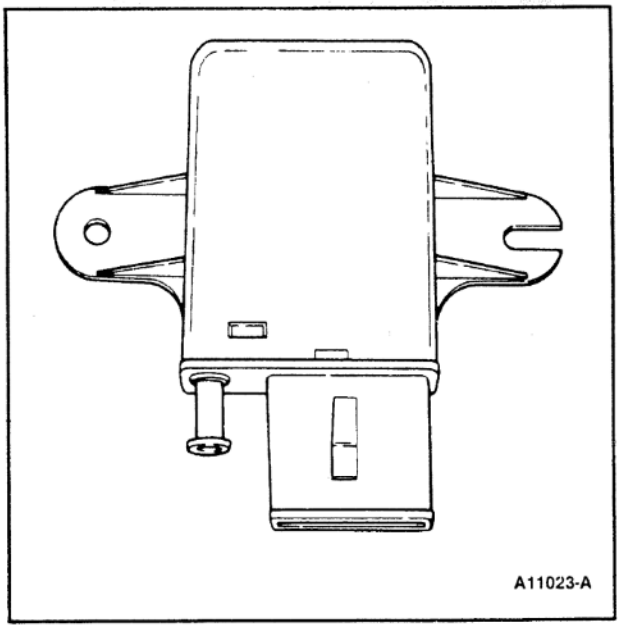


Figure 1 Barometric Pressure (BP) Sensor

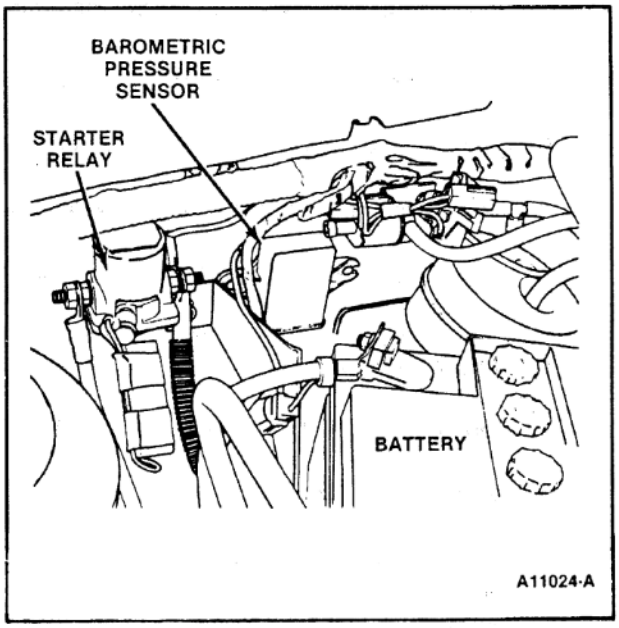
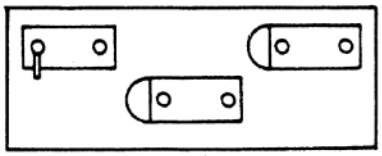


Figure 2 Barometric Pressure (BP) Sensor Location

TITLE	BASIC PART NO.	SYMBOL
Carbon Canister	9D653	

DESCRIPTION

The fuel vapors from the fuel tank and carburetor bowl are stored in the carbon canister until the vehicle is operated, at which time, the vapors will purge from the canister into the engine for consumption.

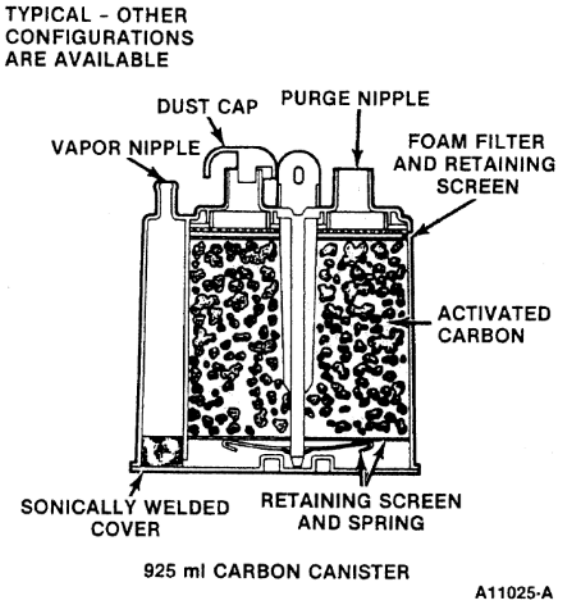


Figure 1 Carbon Canister

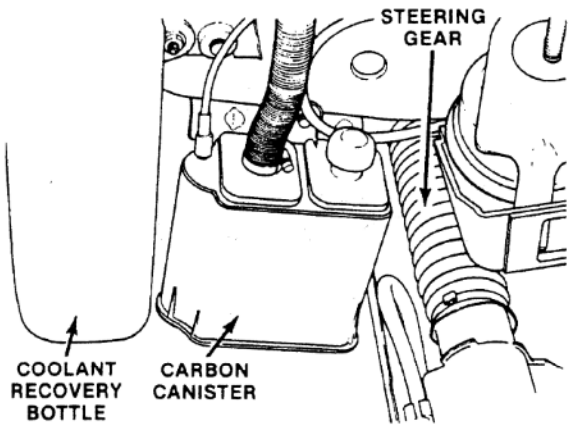


Figure 2 Carbon Canister Location

DIAGNOSIS

There are no moving parts and nothing to wear in the canister.
Check for loose, missing, cracked, or broken connections and parts.

TITLE	BASIC PART NO.	SYMBOL
EGR Control Solenoid	**9D474**	SOL V

DESCRIPTION

Normally Closed Type

This is a normally closed solenoid that, when energized by the ECA, causes vacuum signal to flow to the EGR valve. When the EGR de-energizes the solenoid, the vacuum signal is stopped and the EGR valve is closed.

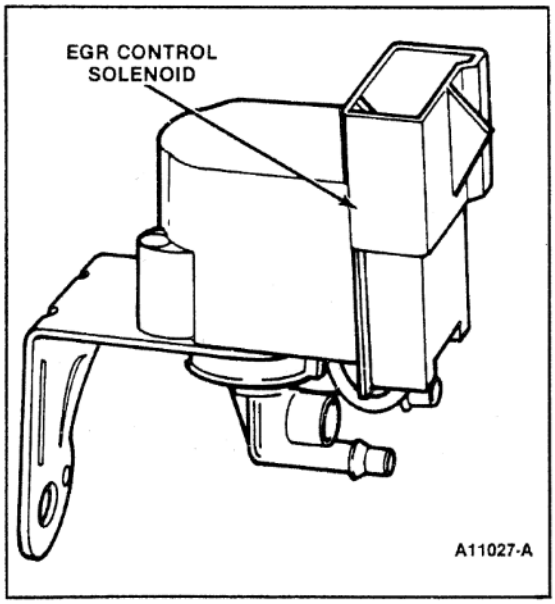


Figure 1 EGR Control Solenoid

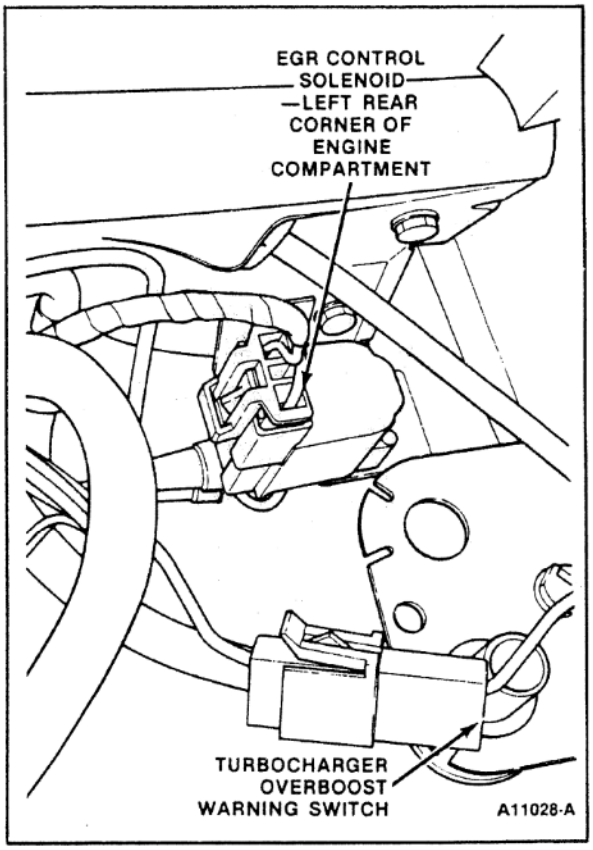


Figure 2 EGR Control Solenoid Location

DIAGNOSIS

The resistance of each solenoid should be 73 ± 5 ohms. If the solenoid is not within these values, the solenoid should be replaced.

The solenoid valve should flow air when solenoid is energized.

For additional information, refer to appropriate EEC diagnosis procedures, Section 4.

NOTE: The valves can be expected to have a very small leakage rate when energized or de-energized. This leakage is not measurable in the field and is not detrimental to valve function.

TITLE	BASIC PART NO.	SYMBOL
EGR Valve-Ported	**9D475**	

DESCRIPTION

The ported EGR Valve is operated by a vacuum signal (only) from EGR Solenoid controlled by the EEC-IV processor which actuates the valve diaphragm. As the vacuum increases sufficiently to overcome the power spring, the valve is opened allowing EGR flow. The amount of flow is dependent on the tapered pintle or the popper position which is a direct result of vacuum signal (Figure 1). The EGR valve is located on the left side of the engine on the upper intake manifold (Figure 2).

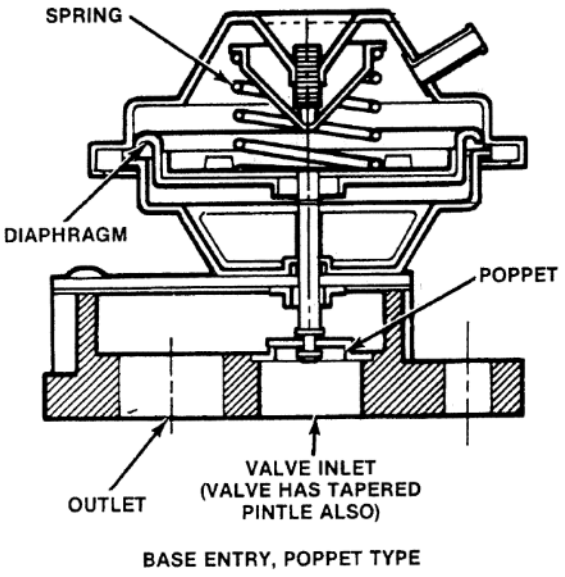


Figure 1 Ported EGR Valve (9D475)

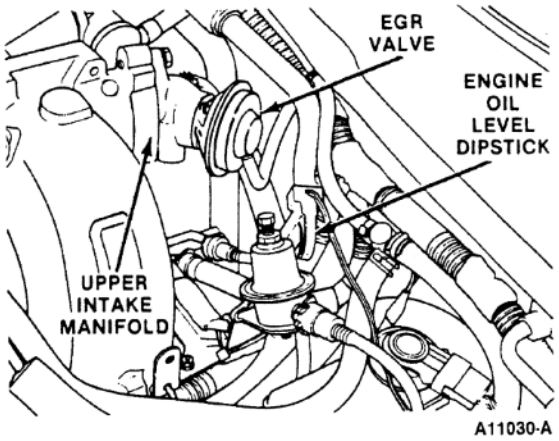


Figure 2

System Descriptions

EGR SYSTEM DESCRIPTION

The Exhaust Gas Recirculation (EGR) System is designed to reintroduce exhaust gas into the combustion chamber to reduce the temperture of combustion. The reduction in combustion temperture is required to lower emissions of Nitrogon Oxides (NO_X) that tend to form during the burning of the air/fuel mixture.

Major components in this system are the:

ECA

EGR Valve

EGR Control Solenoid

The amount of exhaust gas reintroduced and the timing of the EGR are controlled by the ECA. It monitors various factors such as engine speed, engine vacuum, throttle opening and engine temperature to determine when EGR should be applied and in what amount. Vacuum is applied for EGR by manifold vacuum or (during periods of turboboost when vacuum is unavailable) from an aspirator on the turbocharger pressure tube.

Figure 3 Shows the EGR system

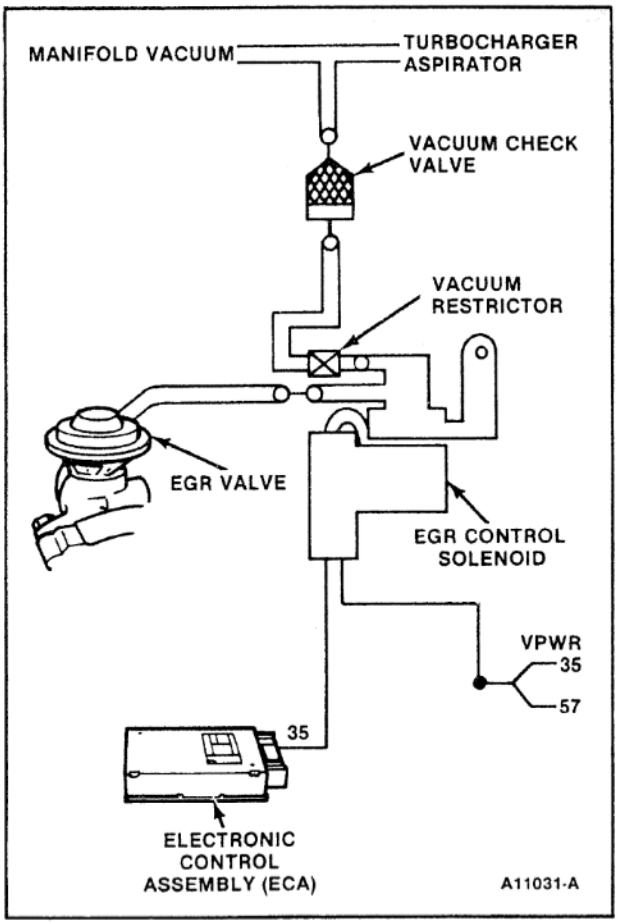


Figure 3 2.3L Turbo EGR System

EGR Diagnosis By Symptom

EGR DIAGNOSIS BY SYMPTOM		
SYMPTOM	**POSSIBLE CAUSE**	**ACTION**
• Rough idle—cold	• EGR valve malfunction.	• Perform EGR valve diagnosis.
	• EGR flange gasket leaking.	• Replace flange gasket and tighten valve attaching nuts or bolts to specification.
	• EGR valve attaching nuts or bolts loose or missing.	• Replace flange gasket and tighten valve attaching nuts or bolts to specification.
	• EGR control solenoid malfunction.	• Perform EGR solenoid diagnosis.
		• Perform load control (WOT) valve diagnosis.
	• Curb idle speed too high or low.	• Reset to specification shown on emission decal.
• Rough idle hot	• EGR valve malfunction.	• Perform EGR valve diagnosis.
	• EGR flange gasket leaking.	• Replace flange gasket and tighten valve attaching nuts or bolts to specification.
	• EGR valve attaching nuts or bolts loose or missing.	• Replace flange gasket and tighten valve attaching nuts or bolts to specification.
	• Curb idle speed too high or low.	• Reset to specification shown on emission decal.

CA11032-A

EGR Diagnosis By Symptom

EGR DIAGNOSIS BY SYMPTOM

SYMPTOM	POSSIBLE CAUSE	ACTION
• Rough running, surge, hesitation, poor part throttle performance—cold	• EGR valve malfunction.	• Perform EGR valve diagnosis.
	• EGR flange gasket leaking.	• Replace flange gasket and tighten valve attaching nuts or bolts to specification.
	• EGR valve attaching nuts or bolts loose or missing.	• Replace flange gasket and tighten valve attaching nuts or bolts to specification.
	• EGR control solenoid malfunction.	• Perform EGR or VCV TVS diagnosis.
	• Ignition timing too low.	• Reset to specification shown on emission decal.
• Rough running, surge, hesitation, poor part throttle performance—hot	• EGR valve malfunction.	• Perform EGR valve diagnosis.
	• EGR flange gasket leaking.	• Replace flange gasket and tighten valve attaching nuts or bolts to specification.
	• EGR valve attaching nuts or bolts loose or missing.	• Replace flange gasket and tighten valve attaching nuts or bolts to specification.
	• EGR control solenoid malfunction.	• Perform EGR control solenoid diagnosis.
	• Blocked or restricted EGR passages in valve or spacer.	• Clean passages in EGR spacer and if necessary, replace EGR valve.
	• Insufficient exhaust back-pressure to activate valve.	• Check exhaust system for leaks.
	• Ignition timing too low.	• Reset to specification shown on emission decal.

CA11033-A

EGR Diagnosis By Symptom

EGR DIAGNOSIS BY SYMPTOM		
SYMPTOM	**POSSIBLE CAUSE**	**ACTION**
• Engine stalls on deceleration —hot and cold	• EGR valve malfunction.	• Perform EGR valve diagnosis.
	• EGR flange gasket leaking.	• Replace flange gasket and tighten valve attaching nuts or bolts to specification.
	• EGR valve attaching nuts or bolts loose or missing.	• Replace flange gasket and tighten valve attaching nuts or bolts to specification.
	• EGR control solenoid malfunction.	• Perform EGR control solenoid diagnosis.
	• Blocked or restricted EGR passage in valve or spacer.	• Clean passages in EGR spacer and if necessary, replace EGR valve.
	• Curb idle speed too high or low.	• Reset to specification shown on emission decal.
	• Ignition timing too low.	• Reset to specification shown on emission decal.

CA11034-A

EGR Diagnosis By Symptom

EGR DIAGNOSIS BY SYMPTOM		
SYMPTOM	**POSSIBLE CAUSE**	**ACTION**
• Engine spark knock or ping	• EGR malfunction.	• Perform EGR valve diagnosis.
	• EGR flange gasket leaking.	• Replace flange gasket and tighten valve attaching nuts or bolts to specification.
	• EGR valve attaching nuts or bolts loose or missing.	• Replace flange gasket and tighten valve attaching nuts or bolts to specification.
	• EGR control solenoid malfunction.	• Perform EGR control solenoid diagnosis.
	• Blocked or restricted passages in valve or spacer.	• Clean passages in EGR spacer and if necessary, replace EGR valve.
	• Insufficient exhaust backpressure to actuate valve.	• Check exhaust system for leaks.
	• Ignition timing too high.	• Reset to specification shown on emission decal.
• Engine stalls at idle—cold	• EGR valve malfunction.	• Perform EGR valve diagnosis.
	• EGR flange gasket leaking.	• Replace flange gasket and tighten valve attaching nuts or bolts to specification.
	• EGR valve attaching nuts or bolts loose or missing.	• Replace flange gasket and tighten valve attaching nuts or bolts to specification.
	• EGR control solenoid malfunction.	• Perform EGR control solenoid diagnosis.
	• Curb idle speed too high or low.	• Reset to specification shown on emission decal.
	• Ignition timing too low.	• Reset to specification shown on emission decal.

CA11035-A

EGR Diagnosis By Symptom

EGR DIAGNOSIS BY SYMPTOM		
SYMPTOM	**POSSIBLE CAUSE**	**ACTION**
• Engine stalls at idle—hot	• EGR valve malfunction.	• Perform EGR valve diagnosis.
	• EGR flange gasket leaking.	• Replace flange gasket and tighten valve attaching nuts or bolts to specification.
	• EGR valve attaching nuts or bolts loose or missing.	• Replace flange gasket and tighten valve attaching nuts or bolts to specification.
	• Blocked or restricted EGR passages in valve or spacer.	• Clean passages in EGR spacer and if necessary, replace EGR valve.
	• Curb idle speed too high or low.	• Reset to specification shown on emission decal.
	• Ignition timing too low.	• Reset to specification shown on emission decal.
• Low power at wide open throttle	• EGR valve malfunction.	• Perform EGR valve diagnosis.
	• EGR flange gasket leaking.	• Replace flange gasket and tighten valve attaching nuts or bolts to specification.
	• EGR valve attaching nuts or bolts loose or missing.	• Replace flange gasket and tighten valve attaching nuts or bolts to specification.
	• Blocked or restricted EGR passages in valve or spacer.	• Clean passages in EGR spacer and if necessary, replace EGR valve.
	• Ignition timing too low.	• Reset to specification shown on emission decal.

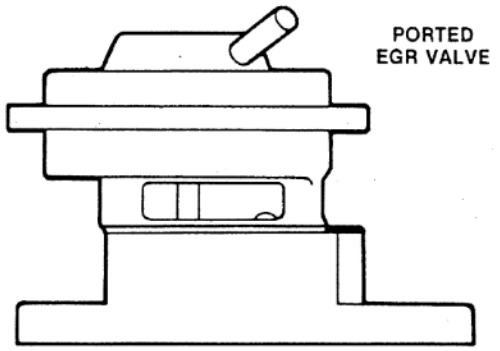
CA11036-A

EGR Diagnosis By Symptom

EGR DIAGNOSIS BY SYMPTOM		
SYMPTOM	**POSSIBLE CAUSE**	**ACTION**
• Engine starts but will not run—engine hard to start or will not start	• EGR valve malfunction.	• Perform EGR valve diagnosis.
	• EGR flange gasket leaking.	• Replace flange gasket and tighten valve attaching nuts or bolts to specification.
	• EGR valve attaching nuts or bolts loose or missing.	• Replace flange gasket and tighten valve attaching nuts or bolts to specification.
	• EGR control solenoid malfunction.	• Perform EGR control solenoid diagnosis.
• Poor fuel economy	• EGR valve malfunction.	• Perform EGR valve diagnosis.
	• EGR flange gasket leaking.	• Replace flange gasket and tighten valve attaching nuts or bolts to specification.
	• EGR valve attaching nuts or bolts loose or missing.	• Replace flange gasket and tighten attaching nuts or bolts to specification.
	• EGR control solenoid malfunction.	• Perform EGR control solenoid diagnosis.
	• Blocked or restricted EGR passages in valve or spacer.	• Clean passages in EGR spacer and if necessary, replace EGR valve.
	• Insufficient exhaust backpressure to activate valve.	• Check exhaust system for leaks.
	• Ignition timing too low.	• Reset to specification shown on emission decal.

CA11037-A

EGR Valve Functional Diagnosis

PORTED EGR VALVE	 9D475 A11040-A

1. Make certain that all vacuum hoses are correctly routed and securely attached. Replace cracked, crimped or broken hoses.
2. Make certain there is no vacuum to the EGR valve at idle with the engine at normal operating temperature.
3. Install a tachometer.
4. Disconnect the Idle Air Bypass Valve (9F715) electrical connector .
5. Remove the vacuum supply hose from the EGR valve nipple, Plug the hose.
6. Start engine, idle with transmission in NEUTRAL, and observe the engine idle speed. If necessary, adjust idle speed to the emission decal specification.
7. Slowly apply 5-10 inches of mercury vacuum to the EGR valve vacuum nipple using a hand vacuum pump.
8. When vacuum is applied to the EGR valve and any of the following occur, replace the valve:
   - Engine does not stall.
   - Idle speed does not drop more than 100 rpm.
   - Idle speed does not return to normal (±25 rpm) after the vacuum is removed.
9. Reconnect the idle air bypass valve electrical connector.
10. Unplug and reconnect the EGR vacuum supply hose.
11. The EGR system is OK, refer to the Diagnostic Routines in Section 2.

TITLE	BASIC PART NO.	SYMBOL
Electronic Control Assembly	**12A650**	

DESCRIPTION

The center of the EEC IV system is a microprocessor called the Electronic Control Assembly (ECA). The ECA, (Figure 1), receives data from a number of sensors and other electronic components (switches, relays, etc.). The ECA contains a specific calibration for optimizing emissions, fuel economy, and driveability. Based on information received and programmed into its memory, the ECA generates output signals to control various relays, solenoids, and other actuators.

The ECA in the EEC IV system is a microprocessor like the one in the other EEC systems. One significant difference is that this ECA has the calibration module located inside the ECA assembly, unlike the EEC III system.

The ECA is found in the passenger compartment under the glove box (Figure 2).

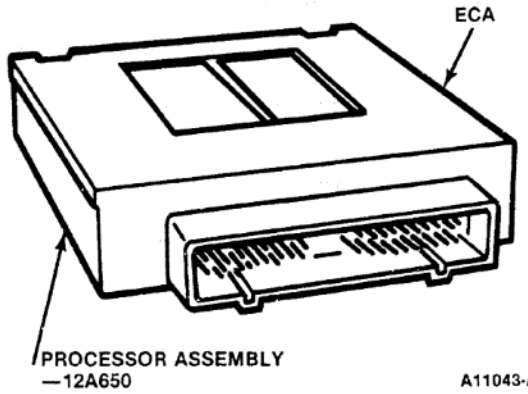


Figure 1 Electronic Control Assembly (ECA)

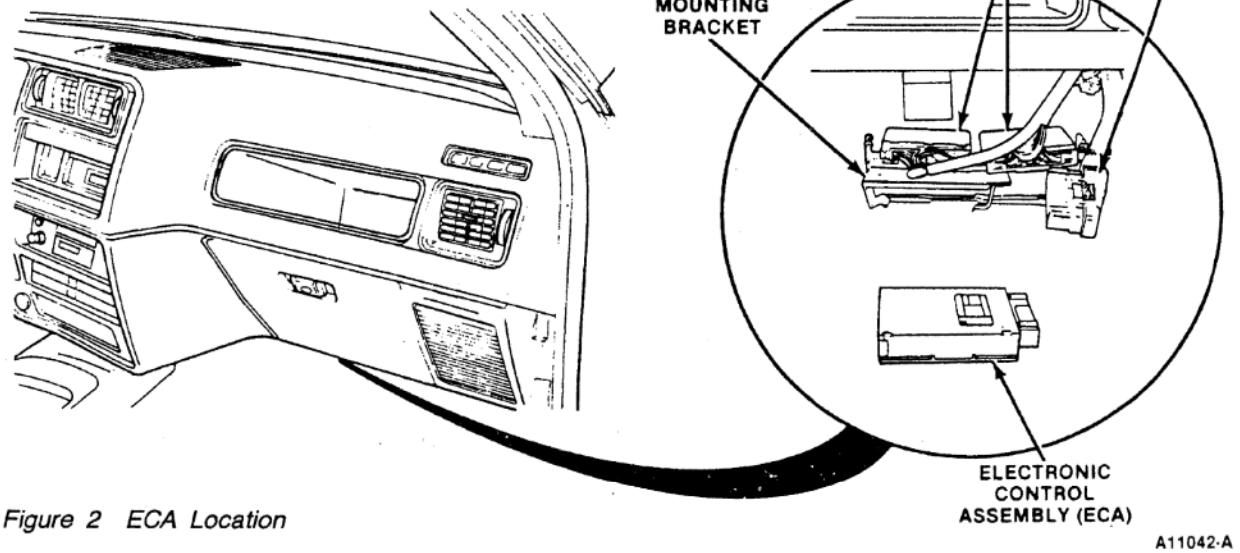


Figure 2 ECA Location

DIAGNOSIS

The Electronic Control Assembly is diagnosed as part of the EEC system, Section 4.

TITLE	BASIC PART NO.	SYMBOL
Engine Coolant Temperature Sensor	**12A648**	

DESCRIPTION

The Engine Coolant Temperature (ECT) Sensor, (Figure 1) detects the temperature of engine coolant and supplies the information to Electronic Control Assembly (ECA).

The ECT sensor is threaded into the intake manifold (Figure 2). For engine control applications, the ECT signal is used to modify ignition timing, EGR flow, and air to fuel ratio as a function of engine coolant temperature.

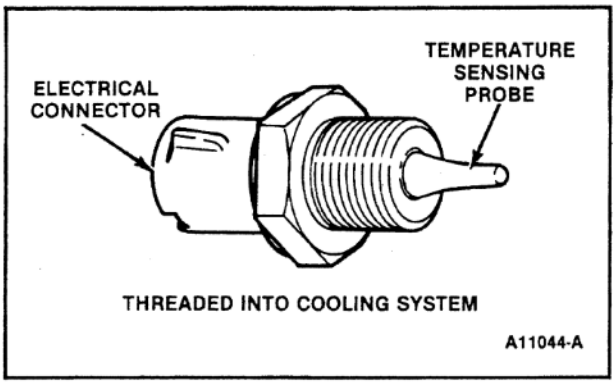


Figure 1 Engine Coolant Temperature (ECT) Sensor

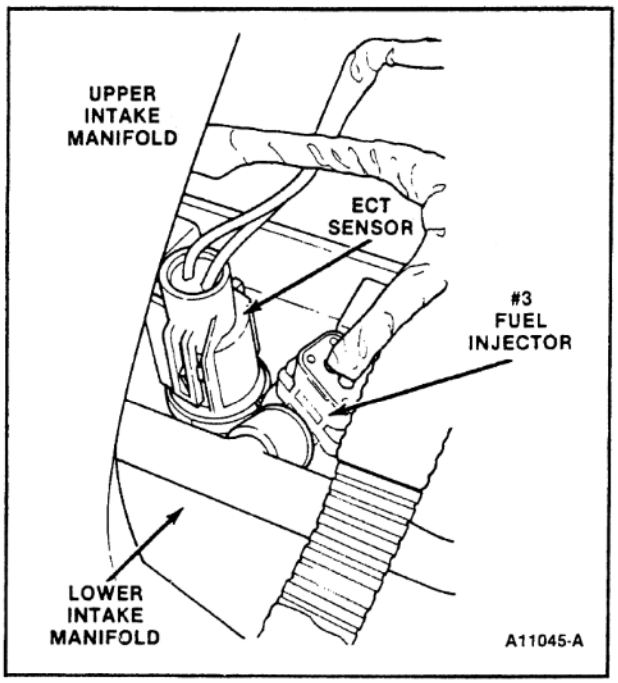


Figure 2 ECT Sensor Location

DIAGNOSIS

The ECT Sensor is diagnosed as part of the EEC System, Section 4.

TITLE	BASIC PART NO.	SYMBOL
Exhaust Gas Oxygen Sensor	**9F472**	

DESCRIPTION

The EGO Sensor (Figure 1) supplies ECA with a signal which indicates either a rich or lean condition during engine operation.

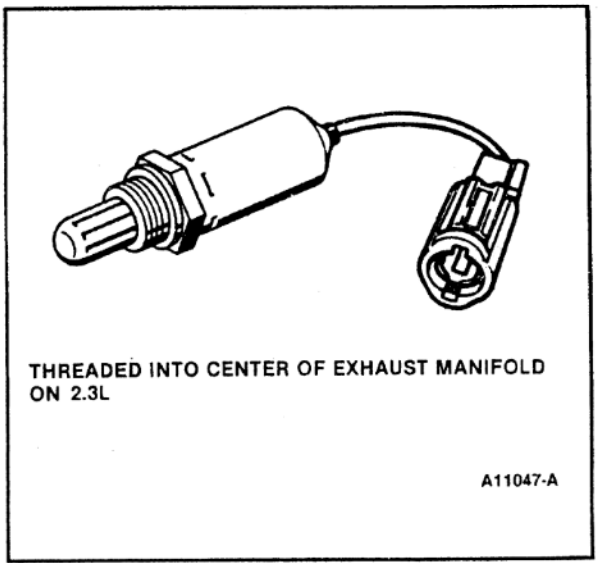


Figure 1 Exhaust Gas Oxygen (EGO) Sensor

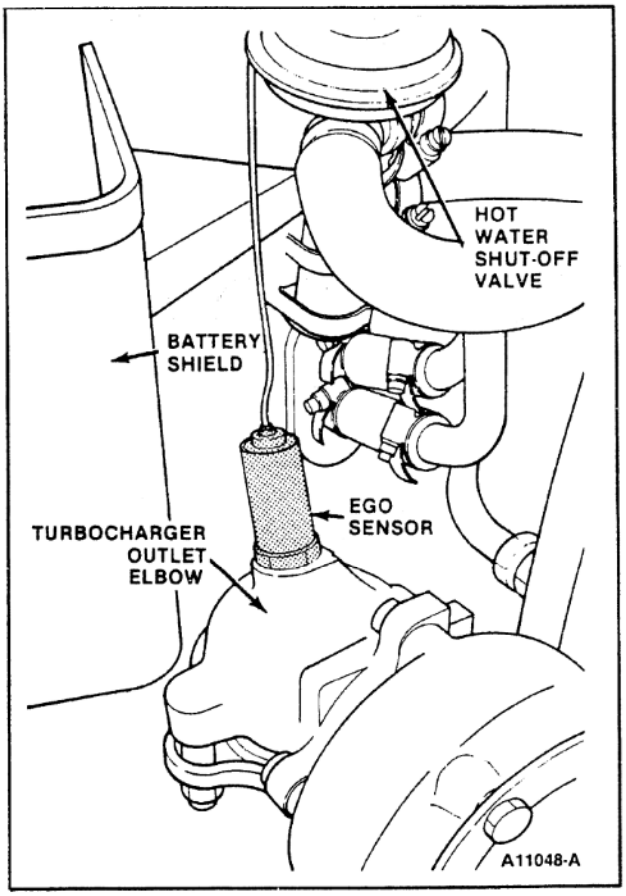


Figure 2 EGO Sensor Location

DIAGNOSIS

Refer to appropriate EEC Diagnosis procedures, Section 4.

TITLE	BASIC PART NO.	SYMBOL
Fuel Injector	**9F593**	

DESCRIPTION

The Fuel Injector, (Figure 1) is a solenoid operated valve that meters fuel flow to the engine. The injector is opened and closed a constant number of times per crank revolution. The amount of fuel is controlled by the length of time it is held open.

The injector is normally closed and is operated by a signal from the Electronic Engine Control (EEC) module.

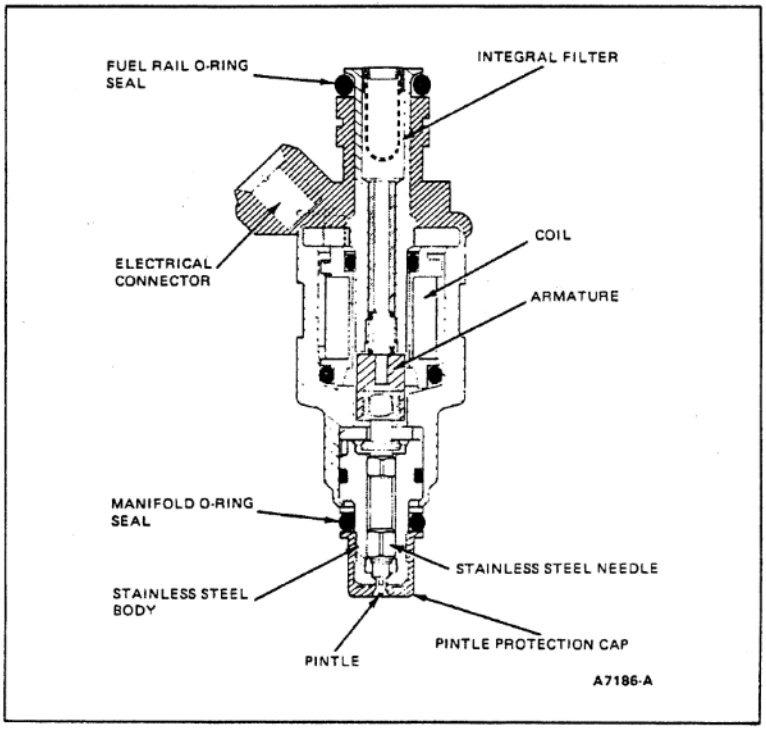


Figure 1 Fuel Injector

DIAGNOSIS

NOTE: Do not apply 12 volts to the injector. The solenoid will be damaged internally in a matter of seconds.

For diagnosis, refer to the appropriate EEC system, Section 4.

TITLE	BASIC PART NO.	SYMBOL
Fuel Pressure Damper		

DESCRIPTION

The fuel pressure damper (Figure 1) is designed to dampen the fuel pressure pulses caused by the operation of the electric fuel pump. This is not a field adjustable component even though the old-style damper has an adjustment screw and locknut. The new-style damper (Figure 2) no longer has an adjustment screw or locknut. The location of the fuel pressure damper is in the fuel line near the oil dipstick.

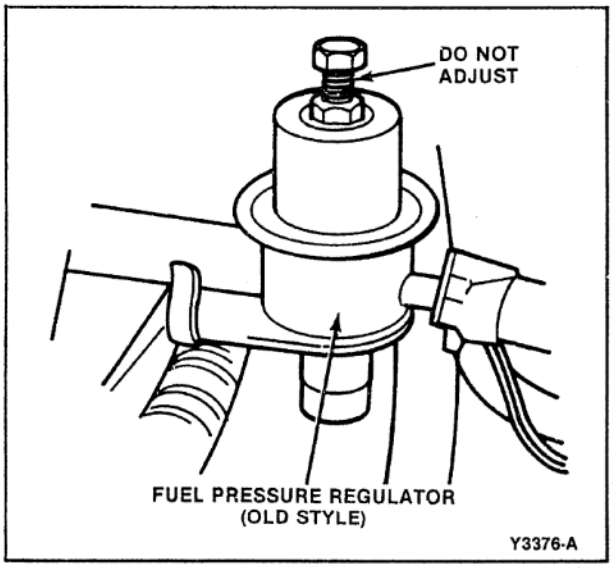


Figure 1 Old-Style Fuel Pressure Damper

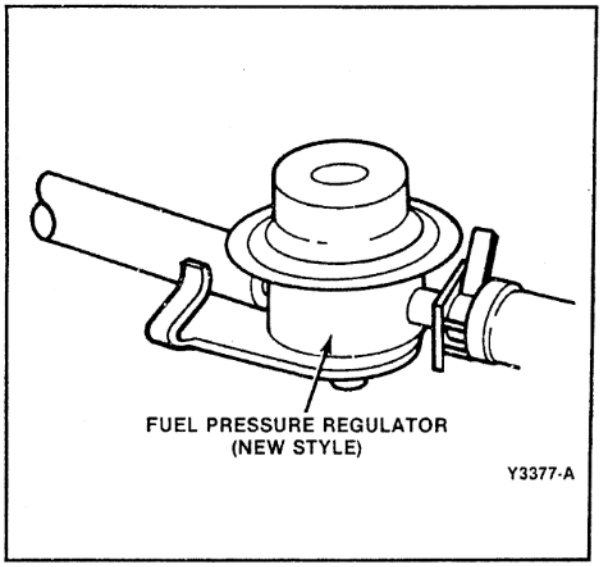


Figure 2 New-Style Fuel Pressure Damper

TITLE	BASIC PART NO.	SYMBOL
Fuel Pressure Regulator	**9C968**	

DESCRIPTION

The EFI Fuel Pressure Regulator, (Figure 1), is attached to the fuel supply manifold assembly upstream of the fuel injectors. It regulates fuel pressure supplied to the injectors.

- The regulator is a diaphragm-operated relief valve in which one side of the diaphragm is exposed to fuel pressure and the other side is subjected to intake manifold pressure for multi-point fuel injection (EFI).
- The nominal fuel pressure is controlled by a spring preload applied to the diaphragm. By exposing the top side of the diaphragm to manifold pressure, a constant pressure drop is maintained across the injectors, for all modes of operation.
- Fuel in excess of that used by the engine is bypassed through the regulator and back to the fuel tank.

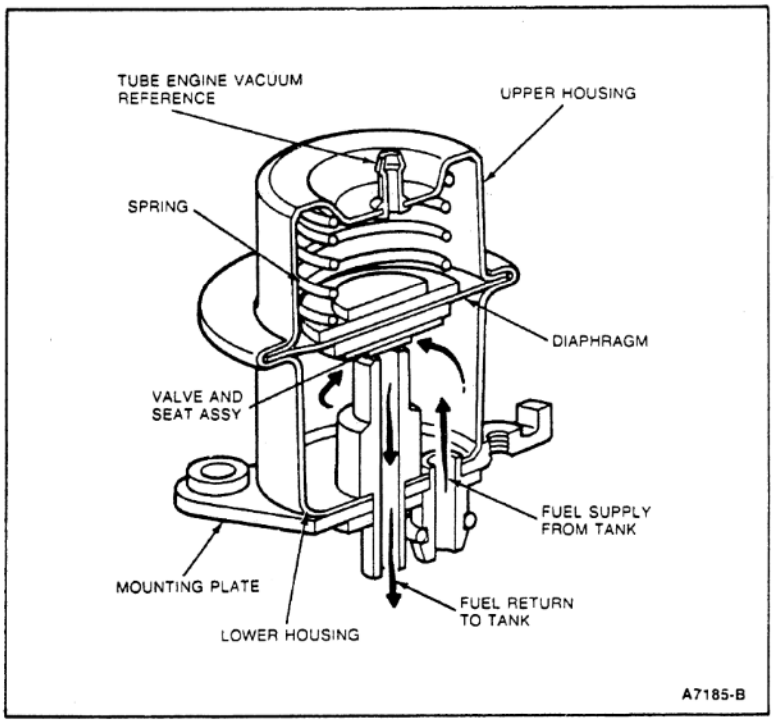


Figure 1 Fuel Pressure Regulator

FUEL PRESSURE REGULATOR DIAGNOSTICS (EFI SYSTEMS)

TEST STEP		RESULT ▶	ACTION TO TAKE
FDE1	DE-PRESSURIZE SYSTEM		
	• Remove fuel tank cap. • Install tool T80L-9974-A or equivalent at the Schrader (fuel relief) Valve on the fuel rail. • Continue on to FDE2.		
FDE2	DIAPHRAGM INTEGRITY CHECK		
	• Start engine, run for 10 seconds. • Turn engine off for 10 seconds. • Repeat above Steps (This is to activate fuel pump and pressurize the fuel rail). • Remove vacuum line at the fuel pressure regulator valve. • Observe if fuel exits the regulator at the vacuum port.	Yes ▶ NO ▶	REPLACE fuel pressure regulator. Check oil for fuel contamination. CHANGE oil and filter if signs of fuel are present (smell of fuel in oil or oil with water-like texture). GO to **FDE3**.
FDE3	PRESSURE CHECK-REGULATOR VALVE		
	• Reconnect vacuum line at fuel pressure regulator valve. • Start and run engine for 30 seconds. • Turn engine off. • Fuel pressure must not drop more than 34 kPa (5 psi) after 60 seconds.	Within specification ▶ Not within specification ▶	GO to **FDE4**. CHECK for line leaks (both fuel and vacuum).
FDE4	VALVE SEAT LEAKAGE CHECK		
	• Relieve pressure in fuel rail. • Remove fuel pressure regulator valve. • Inspect gasket and O-ring for cracks and cuts. • Connect vacuum gauge to the fuel return tube (7/32-inch diameter tube is centered on baseplate). • Apply 20 inches Hg. of vacuum. • Vacuum must not drop below 10 inches Hg. in 10 seconds.	OK ▶ Not OK ▶	REINSTALL fuel pressure regulator. REFER to other drive/ symptom problems (Section 2). REPLACE fuel pressure regulator.

CA9156-A

TITLE	BASIC PART NO.	SYMBOL
Inertia Switch	**9341**	

DESCRIPTION

The Inertia Switch, (Figure 1), is used in conjunction with an electric fuel pump. The purpose of the inertia switch is to shut off the fuel pump in the event of an accident. It consists of a steel ball held in place by a magnet. When a sharp impact occurs, the ball breaks loose from the magnet, rolls up a conical ramp and strikes a target plate which opens the electrical contacts of the switch and thereby shuts off the electric fuel pump. Once the switch is open, it must be manually reset before re-starting the vehicle. The location of the switch is in the spare tire well (Figure 2).

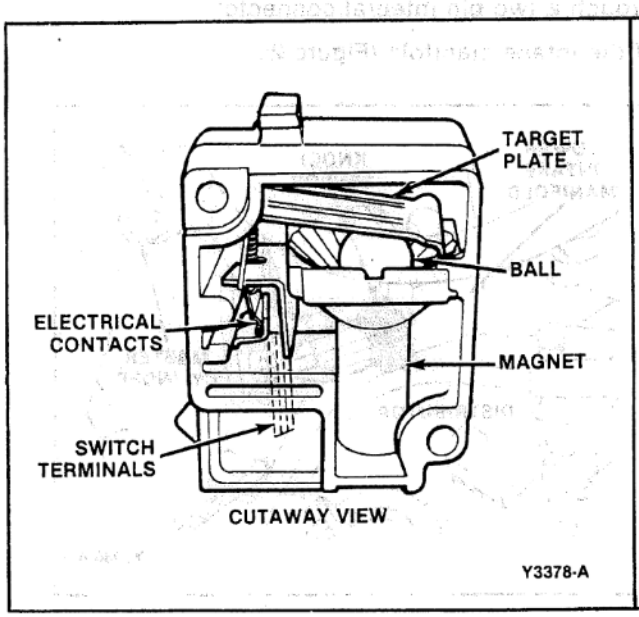


Figure 1 Inertia Switch

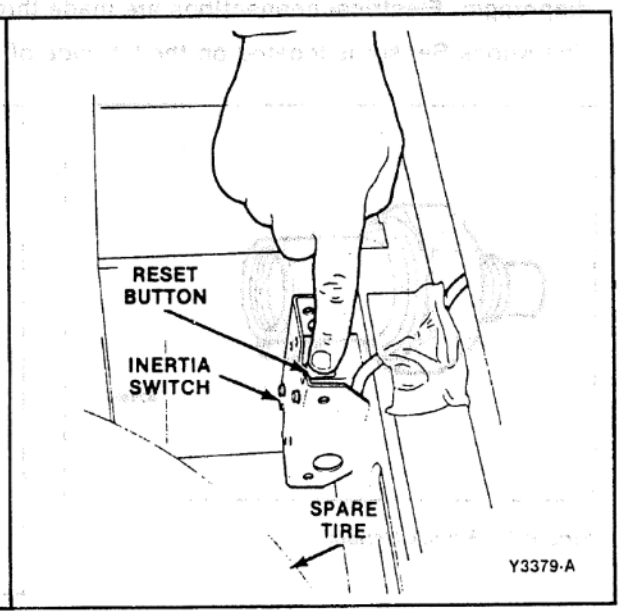


Figure 2 Inertia Switch Location

DIAGNOSIS

RESET INSTRUCTIONS

1. Turn ignition to Off.
2. Check for leaking fuel in the engine compartment, fuel lines and tank(s).
3. If no fuel leak is apparent, reset the switch by pushing the reset button on the top of the switch.
4. Turn ignition switch to Start for a few seconds, then to Off.
5. Again, check for leaking fuel.

WARNING: If you see or smell gasoline at any time other than during fueling, do not reset the switch.

Functional Check

Push down on the reset button to make sure the switch is closed.

Use DVOM with LOS button On and measure voltage across both terminals of the inertia switch. If DVOM reading is greater than 0.3V, replace the inertia switch.

NOTE: In the closed position, the button can be depressed an additional 1/16-inch against a spring. This is a normal condition and does not adversly effect the switch operation.

TITLE	BASIC PART NO.	SYMBOL
Knock Sensor	**12A699**	

DESCRIPTION

The Knock Sensor, (Figure 1), is a piezoelectric accelerometer with the sensor designed to resonate at approximately the same frequency as the engine knock frequency. The sensor uses the resonant frequency to mechanically amplify the vibrations. This method allows relatively large signals to be achieved without electrical amplification and with small package size.

The sensor has a thin circular piezoelectric ceramic disk which is bonded to a metal diaphragm. Electrical connections are made through a two pin integral connector.

The Knock Sensor is located on the left side of the intake manifold (Figure 2).

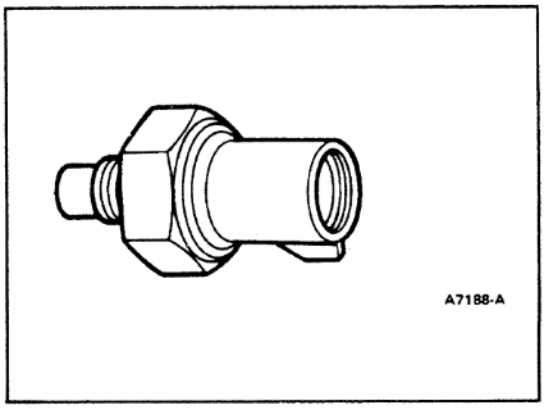


Figure 1 Knock Sensor

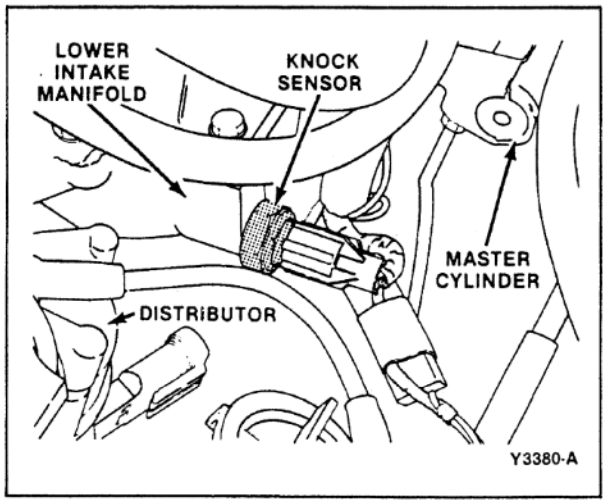


Figure 2 Knock Sensor Location

DIAGNOSIS

The knock sensor is diagnosed as part of the EEC System, Section 4.

Part Number	Resonant Frequency	Color	Usage	Thread
E3ZSF-AA	5.7K	Gray	2.3L (Turbo)	M12 x 1.5mm-6g

TITLE	BASIC PART NO.	SYMBOL
Overboost Warning Switch	**10D883**	

DESCRIPTION

The switch assembly has a pressure switch (Figure 1) to trigger the overboost buzzer. The overboost warning switch is located on the left hand fender apron (Figure 2).

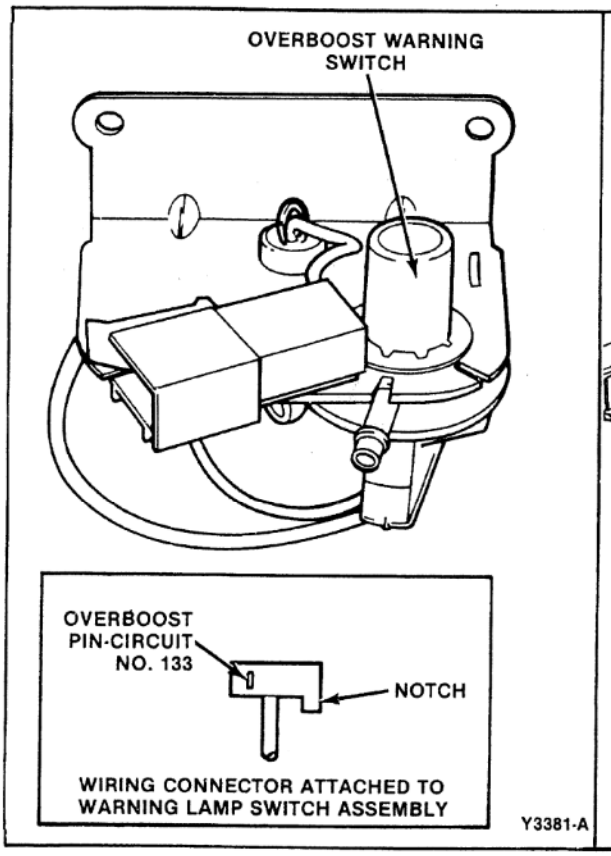


Figure 1 Manifold Pressure Warning Indicator Switch Assembly

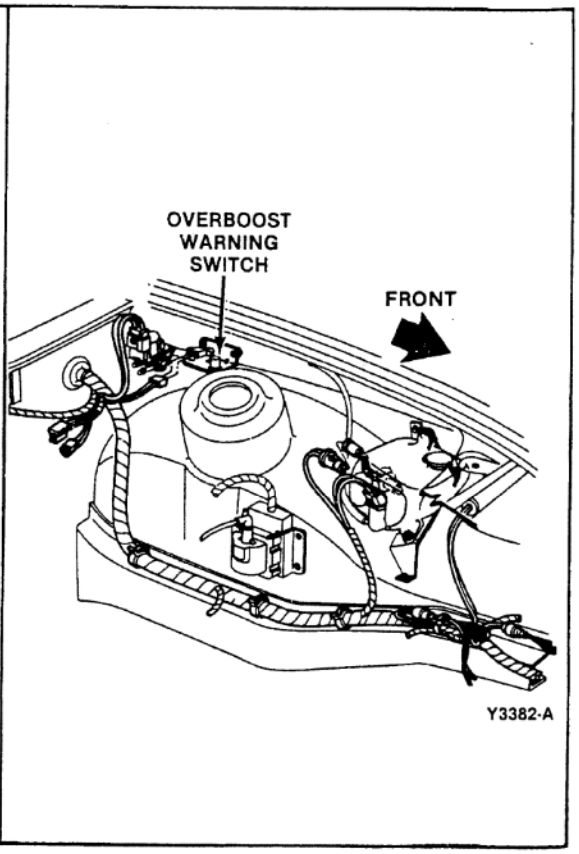


Figure 2 Overboost Warning Switch Location

DIAGNOSIS

Disconnect the wiring harness connector from the warning lamp switch assembly. Using a test lamp or equivalent device, determine if the pin is connected to ground when pressure is applied as follows:

1. Overboost lamp switch check: The other pin on the connector, joining to Circuit 133, should be connected to ground when a pressure of 17.5 psi or greater is applied.

TITLE	BASIC PART NO.	SYMBOL
Positive Crankcase Ventilation (PCV) Valve	**6A666**	

DESCRIPTION

The PCV valve (Figure 1) is responsible for venting crankcase vapers to the intake manifold so that they will be burned during combustion. It is a major component in the Positive Crankcase Ventilation System (Figure 2).

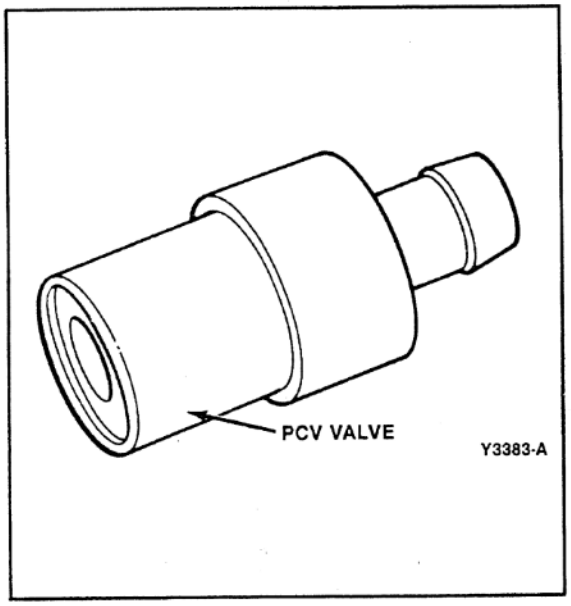


Figure 1 PCV Valve

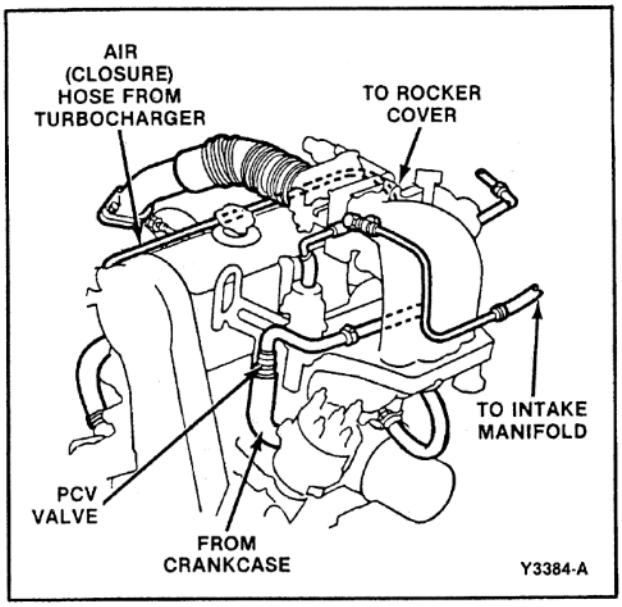


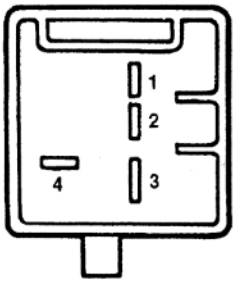
Figure 2 PCV System

TITLE	BASIC PART NO.	SYMBOL
Relay Assembly EEC (Power)	**12A646**	

DESCRIPTION

EEC power relays are in parallel with the ignition switch and provide power to the EEC module. Power relays also provide reverse battery protection and increased load handling to improve ignition switch reliability.

Specifications	Power Relay	Time Delay Power Relay
Pull-in Voltage	8.5V DC max	9 V DC max
Millivolt Drop	10 mv/amp	15 mv/amp
Coil Current	220 ma@12.8V DC	220 ma@14.4V DC
Drop-out Voltage	1-4 V DC	4.5 V DC



EEC POWER RELAY

1. TO BATTERY NEG. POST
2. KEY POWER (RUN AND CRANK)
3. V POWER TO EEC MODULE
4. TO BATTERY POS. POST

Y3385-A

Figure 1 Relay Assembly

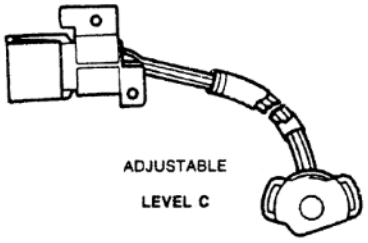
Location

Under the dash panel, to the left of the glove box.

TITLE	BASIC PART NO.	SYMBOL
Throttle Position Sensor (Rotary)	**9B989**	

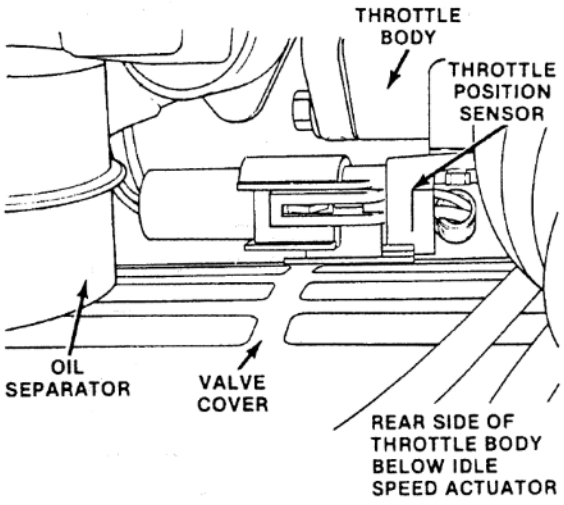
DESCRIPTION

The Throttle Position (TP) Sensor (Rotary), Figure 1, supplies the ECA with a signal proportional to opening angle of carburetor throttle plates. It is located on the rear of the throttle body below the idle speed actuator (Figure 2).



Y3386-A

Figure 1 Throttle Position (TP) Sensor (Rotary)



Y3387-A

Figure 2 Throttle Position Sensor Location

ADJUSTMENT

This procedure can be used to check and/or adjust level C sensors only:

1. Install an EEC-IV Breakout Box, Rotunda T83L-50 EEC-IV, or equivalent.
2. Attach a DVOM, Rotunda 014-00407 or equivalent, on 20V scale. Connect the positive lead (+) to test Pin 47 and the negative lead (—) to test Pin 46.
3. Turn ignition key to Run position, (do not start engine).
4. Adjust TP Sensor (rotate) until the DVOM reads 1.0V (0.9-1.1).
5. Tighten TP Sensor screws to 1.2-1.8 N·m (11-16 lb-in).
6. While watching the DVOM, move the throttle to wide open and back to idle position. For proper operation, the DVOM should move from 1.0 to at least 4.0 and back to 1.0V.
7. Perform EEC-IV Quick Test, Section 4.

DIAGNOSIS

The throttle Position Sensor is diagnosed as part of the EEC System, Section 4.

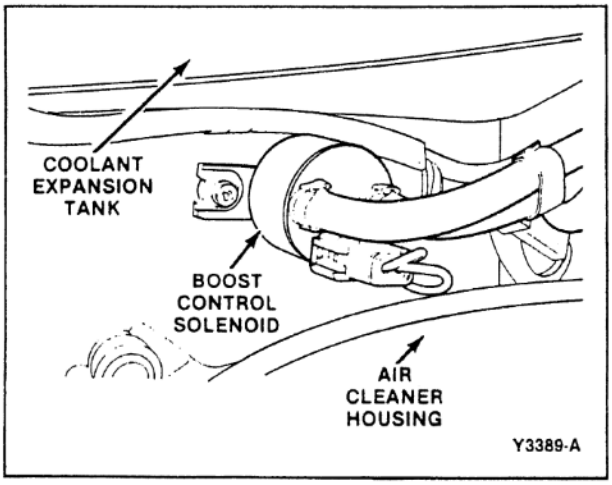
TITLE	BASIC PART NO.	SYMBOL
Turbocharger Boost Control Solenoid	**9K378**	

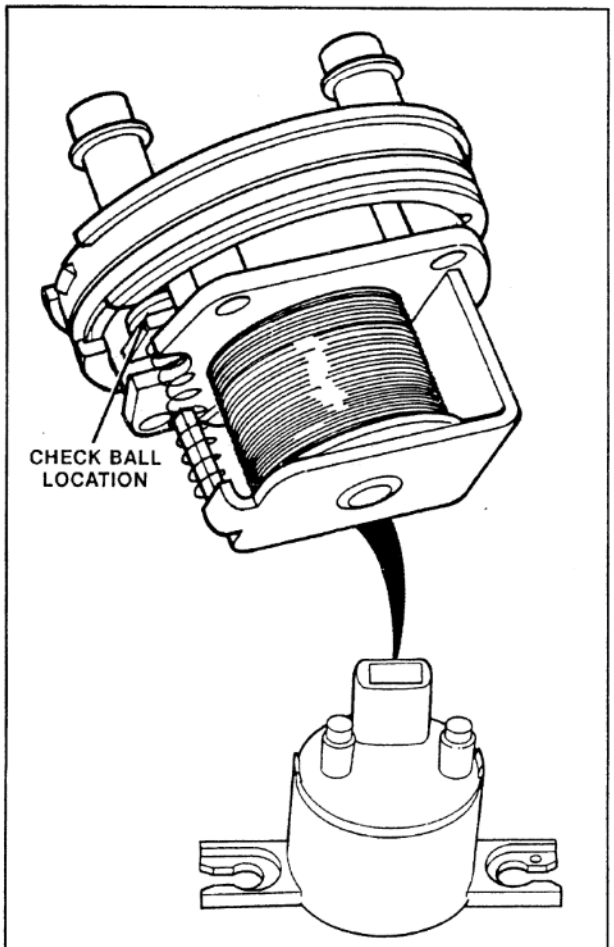
DESCRIPTION

The ECA uses this solenoid (Figure 1) to control boost pressure to the turbocharger wastegate. This is a normally closed solenoid that, when energized by the ECA, allows boost pressure from the turbocharger compressor outlet to bleed through the solenoid back into the turbocharger compressor.

Without the boost control solenoid, the wastegate would open at approximately 69 kPa (10 psi). When the ECA energizes the solenoid, boost pressure into the engine can increase up to approximately 103 kPa (15 psi). The solenoid will open and close at 40 Hz (40 cycles per second). The amount of boost depends on engine requirements, as calibrated into the ECA.

The boost control solenoid is located on the right fender well between the coolant expansion tank and air cleaner housing (Figure 2).





TITLE	BASIC PART NO.	SYMBOL
Vacuum Check Valve	**12A197**	 VCK-V

DESCRIPTION

A vacuum check valve (Fig. 1) blocks air flow in one direction. It allows free air flow in the other direction. The check side of this valve will hold the highest vacuum seen on the vacuum side. If not, replace it. On XR4Ti: The check valve is used in the EGR system.

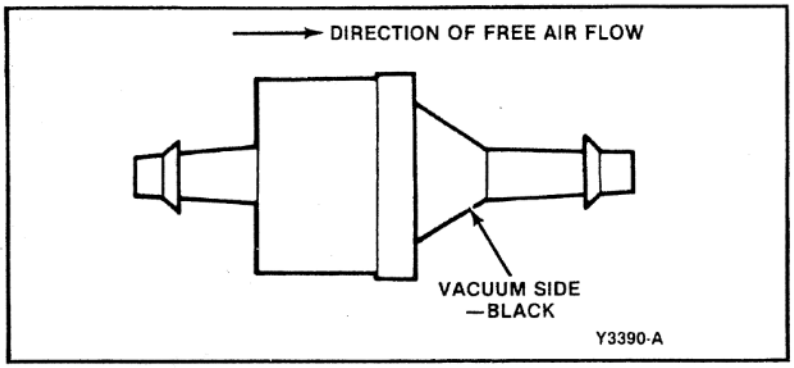


Figure 1 Vacuum Check Valve

DIAGNOSIS

Apply 54 kPa (16 in. Hg.) vacuum to "check" side of valve and trap. If vacuum remains above 50.6 kPa (15 in. Hg.) for 10 seconds, the valve is acceptable.

TITLE	BASIC PART NO.	SYMBOL
Vane Air Flow Meter	12B529	

DESCRIPTION

The Vane Air Flow Meter, (Figure 1), measures air flowing into the engine and is mounted between the air cleaner and the air throttle body assembly. The meter contains a movable vane directly connected to an electrical device known as a potentiometer. Air, rushing through the vane air flow meter, changes the position of the vane and the potentiometer. The potentiometer relays vane position information to the EEC IV module. The EEC IV module can then translate vane position information into the amount of air flowing into the engine.

Inside the vane air flow meter is an air temperature sensor. This sensor constantly monitors the temperature of the air flowing into the engine. This information is also transmitted to the EEC IV module.

The EEC IV module computes air flow and air temperature information, then adjusts the fuel flow to obtain the optimum air/fuel mixture. The Vane Air Flow Meter is located between the air cleaner housing and the flexible tube to the turbocharger (Figure 2).

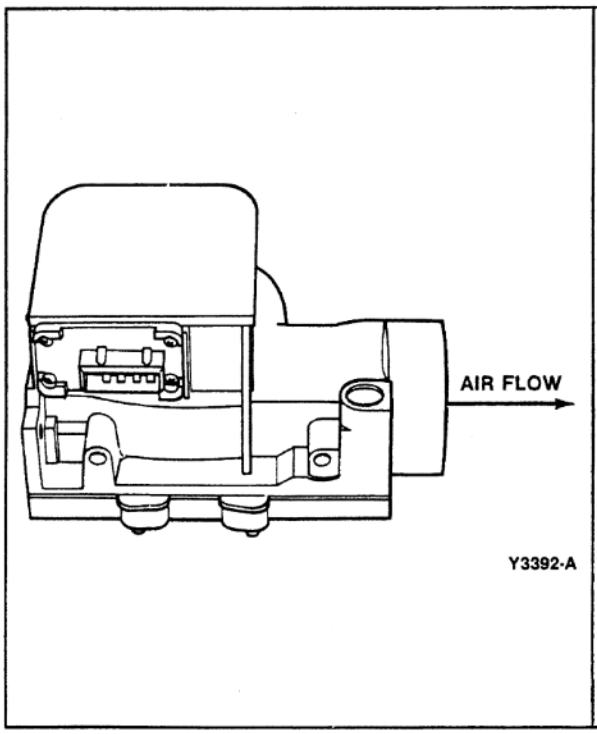


Figure 1 Vane Air Flow Meter

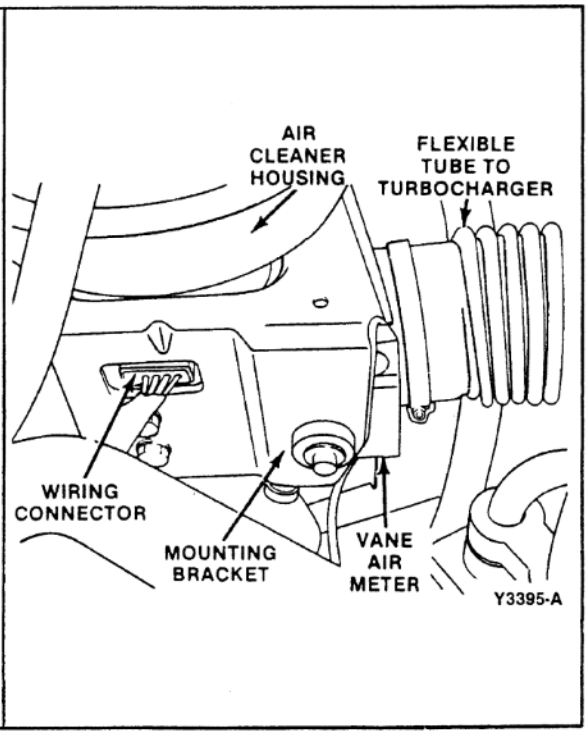


Figure 2 Vane Air Flow Meter Location

DIAGNOSIS

Refer to EEC IV Diagnosis procedures, Section 4.

SECTION 4

Contents

EEC IV—Quick Test

When To Use This Diagnostic Procedure 4-1

Quick Test Description 4-1

Quick Test 4-2

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When To Use This Diagnostic Procedure

This diagnostic procedure is only used on Electronic Engine Control (EEC-IV) equipped vehicles when the Diagnostic Routines, Section 2 instruct you to perform EEC-IV Diagnostics. It is divided into two test formats. **Quick Test**, a functional EEC-IV system test, and **Pinpoint Tests**, a number of specific component tests.

To test and service the EEC-IV subsystem, perform the Quick Test first. **If the vehicle passes all three phases of the Quick Test: Key On, Engine Off, Engine Running, and Continuous Testing without running any Pinpoint Tests, you will know the EEC-IV subsystem is OK and the vehicle's problem exists somewhere else other than in the EEC-IV subsystem.** However, if a Step of the Quick Test fails, perform only the Pinpoint Tests specified by the failed Step. Do not begin any Pinpoint Test without following the instructions at the beginning of the Section.

After all tests and services have been completed, repeat the entire Quick Test to make sure the EEC-IV subsystem works properly.

Quick Test Description

The Quick Test is a functional test of the EEC-IV system consisting of basic Test Steps (described below). These Steps must be carefully followed in sequence, otherwise mis-diagnosis, or the replacement of non-faulty components may result.

Quick Test Steps

1. Visual Check and Vehicle Preparation
   - Checks for obvious faults.
   - Properly prepares the vehicle for testing.
2. Equipment Hook-up
   - Ensures that the proper equipment for gathering test data is ready, prior to testing.
3. Key On, Engine Off Self-Test
   - Is a static check of processor inputs and outputs.
4. Computed Timing Check
   - Verifies the system ability to compute and maintain a fixed spark timing during Self-Test.
5. Engine Running Self-Test
   - Is a dynamic check with the engine in operation.
6. Continuous Self-Test
   - Checks the sensor inputs for opens and shorts while the vehicle is in operation.

The Key On, Engine Off and Engine Running Self-Tests are intended to detect faults present at the time of testing only, not intermittent faults. Intermittent faults are detected by Continuous Self-Test.

A continuous memory code is information collected and stored from an intermittant fault detected in a previous drive-cycle, the fault may not be present at this time.

WARNING: Anyone who departs from the instruction provided in this publication must first establish that he compromises neither his personal safety nor the vehicle integrity by his choice of methods, tools or parts.

QUICK TEST: Visual Check And Vehicle Preparation

1.0

Correct test results for the Quick Test are dependent on the proper operation of related non-EEC components systems. It may be necessary to correct faults in these areas before EEC will pass Quick Test. Refer to Diagnostic Routines, Section 2 for service.

Before hooking up any equipment to diagnose the EEC system, make the following checks:

1. Verify the condition of air cleaner and ducting. These components may be removed and reinstalled as necessary for service and/or inspection.
2. Check all engine vacuum hoses for:
   - Leaks or pinched hoses.
   - Proper emission routing per Vehicle Emission Control Information (VECI) Decal.
3. Check the EEC system wiring harness electrical connections for:
   - Proper connections.
   - Loose or detached connectors, wires and terminals.
   - Corrosion.
   - Proper routing of harness.

It may be necessary to disconnect or disassemble the connector assembly to perform some of the inspections. (Note the location of each pin before disassembly.)

4. Check processor, sensors and actuators for physical damage.
5. Perform all safety steps required to start and run operational vehicle tests.
6. Apply the emergency brake. Place shift lever in Park; Neutral for manual transmission.
7. **Turn Off all electrical loads** such as the radio, lamps, air conditioner, etc. Be sure doors are closed whenever readings are made.
8. Verify engine coolant is at the specified level.
9. Start engine and idle until the upper radiator hose is hot and pressurized and the throttle is off fast idle. While the engine is operating, check for leaks around the exhaust manifold, EGO sensor, and vacuum hose connections.

   NOTE: If engine will not start, starts but stalls, idles rough or runs rough continue through Quick Test Step 3.0. If any of the above conditions are still present after a pass code 11 in the Key On, Engine Off Self-Test, go to Pinpoint Test Step A2 for no start or diagnostics by symptom in the proper Engine Supplement Section for stalls or roughness.

10. Turn ignition Key Off.
11. Service items as required, and proceed to equipment hook-up, Step 2.0

QUICK TEST: Equipment Hook-Up

2.0

Using the STAR tester:

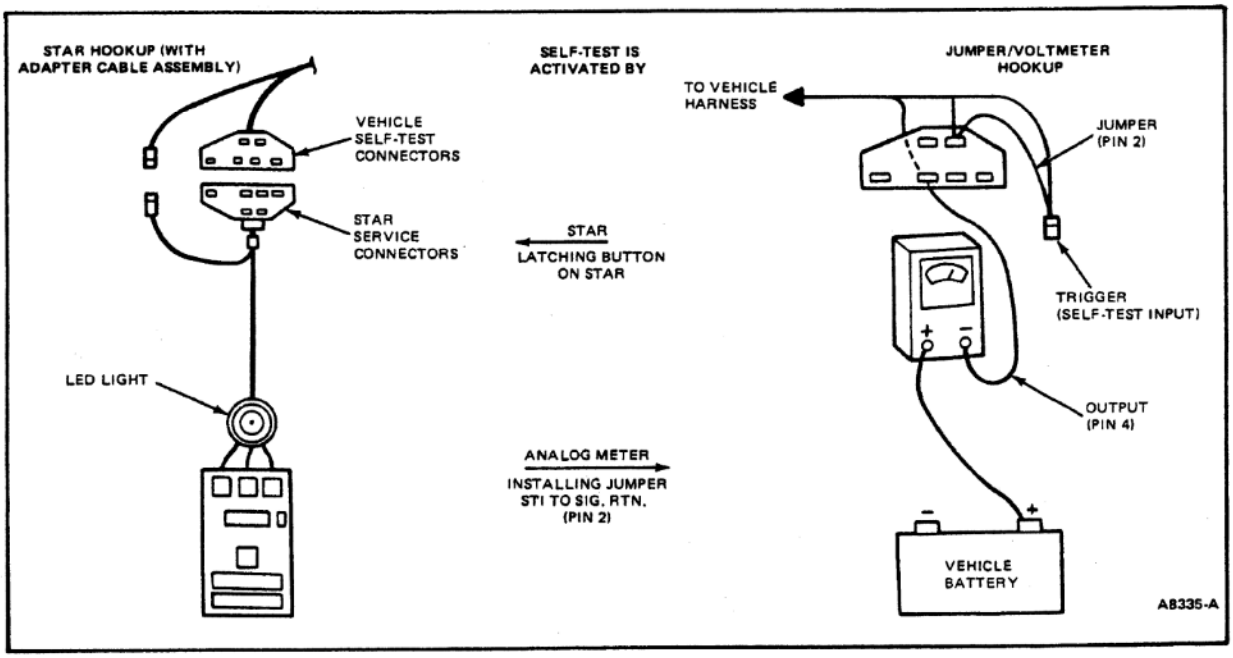
- Turn the ignition key Off.
- Connect the color-coded adapter cable leads to the STAR tester.
- Connect the adapter cable's two service connectors to the vehicle's appropriate Self-Test connectors.
- Connect the timing light.

After equipment hook-up, GO to Quick Test Step 3.0

Using analog voltmeter:

- Turn ignition key Off.
- Connect a jumper wire from Self-Test Input (STI) to Pin 2, Signal Return on the Self-Test connector (refer to the diagram below).
- Set analog VOM on a DC voltage range to read from 0 to 15 volts DC. Connect VOM from battery (+) to Pin 4 Self-Test Output (STO) in the Self-Test connector.
- Connect the timing light.

After equipment hook-up, GO to Quick Test Step 3.0



QUICK TEST: Key On, Engine Off Self-Test

3.0

A	CODE OUTPUT

Correct test results for the QUICK TEST are dependent on the proper operation of related non-EEC-IV components/systems. It may be necessary to correct any faults in these areas before EEC-IV will pass the QUICK TEST. Refer to the diagnostic routines, section 2 for proper servicing.

- Verify that the vehicle has been properly prepared per QUICK TEST STEPS 1.0 and 2.0.
- Place transmission in neutral or park. Set parking brake. Place A/C or heater control to off.
- Activate SELF-TEST.
- Place key in run position to start SELF-TEST.

  NOTE: Do not depress throttle during SELF-TEST.
- Observe and record all service codes indicated. One of the following outputs will occur.

  NOTE: Continuous memory codes recorded in this step will be used for diagnosis later in QUICK TEST Step 6.0!

RESULTS			ACTION TO TAKE
Code Format			
Key On Engine Off	Separator	Continuous Memory	
11	1(0)	11 ▶	KEY ON, ENGINE OFF and CONTINUOUS MEMORY indicate a pass. Go To QUICK TEST STEP 4.0. If vehicle is a no start, go to Pinpoint Test Step A2
ANY CODE(S)	1(0)	11 ▶	KEY ON, ENGINE OFF TEST indicates a fault. Record codes and Go To QUICK TEST STEP 3.0B.
ANY CODE(S)	1(0)	ANY CODE(S) ▶	KEY ON, ENGINE OFF and CONTINUOUS MEMORY indicate a fault. Record ALL codes. DO NOT REPAIR CONTINUOUS MEMORY CODES AT THIS TIME! KEY ON, ENGINE OFF and ENGINE RUNNING codes must be repaired first. Go To QUICK TEST STEP 3.0B.
11	1(0)	ANY CODE(S) EXCEPT 15 ▶	CONTINUOUS MEMORY indicates a fault. DO NOT REPAIR THESE CODES AT THIS TIME! KEY ON, ENGINE OFF and ENGINE RUNNING codes must be repaired first. Go To QUICK TEST STEP 4.0.
11	1(0)	15 ▶	Go To Pinpoint Test Step Q10.
NO CODES OUTPUTTED			Repeat SELF-TEST and verify that no service codes are present. Go To Pinpoint Test Step Q1.

*Star tester displays a 10 in place of a 1 for the single digit separator code, therefore the separator code is expressed in the results column as 1(0).

QUICK TEST: Key On, Engine Off Self-Test

3.0

B	RESULTS AND ACTION TO TAKE

- Using the KEY ON, ENGINE OFF service codes from QUICK TEST step 3.0A, follow the instructions in the ACTION TO TAKE column in this step.
- When more than one service code is received always start with the first code received.
- Whenever a repair is made REPEAT QUICK TEST!

NOTE: Before proceeding to the specified Pinpoint Test, read the instructions on how to use the Pinpoint Tests at the beginning of the Pinpoint Test section.

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RESULTS ▶	ACTION TO TAKE
Key On, Engine Off Service Codes	2.3L EFI TURBO
15 GO to Pinpoint Step ▶	Q12
19 GO to Pinpoint Step ▶	*
21 GO to Pinpoint Step ▶	DE1
22 GO to Pinpoint Step ▶	DF1
23 GO to Pinpoint Step ▶	DH1
24 GO to Pinpoint Step ▶	DA1
26 GO to Pinpoint Step ▶	DK1
31 GO to Pinpoint Step ▶	*
32 GO to Pinpoint Step ▶	*
34 GO to Pinpoint Step ▶	*
35 GO to Pinpoint Step ▶	*
51 GO to Pinpoint Step ▶	DE10
52 GO to Pinpoint Step ▶	*
53 GO to Pinpoint Step ▶	DH3
54 GO to Pinpoint Step ▶	DA10
56 GO to Pinpoint Step ▶	DK10
61 GO to Pinpoint Step ▶	DE20
62 GO to Pinpoint Step ▶	*
63 GO to Pinpoint Step ▶	DH10
64 GO to Pinpoint Step ▶	DA20
66 GO to Pinpoint Step ▶	DK20
67 GO to Pinpoint Step ▶	FA1
68 GO to Pinpoint Step ▶	*
81 GO to Pinpoint Step ▶	*
82 GO to Pinpoint Step ▶	*
83 GO to Pinpoint Step ▶	*
84 GO to Pinpoint Step ▶	*
85 GO to Pinpoint Step ▶	*
87 GO to Pinpoint Step ▶	J1
89 GO to Pinpoint Step ▶	*
No Codes/Code Not Listed	GO to Pinpoint Test Step Q1

QUICK TEST: TIMING CHECK

4.0

TEST STEP	RESULT ▶	ACTION TO TAKE
• If engine is a no start, go directly to Pinpoint Test Step A1 NO START. • If engine starts but stalls go directly to DIAGNOSTIC BY SYMPTOM in the proper ENGINE SUPPLEMENT SECTION. • Key off, wait 10 seconds. • Verify SELF-TEST trigger has been activated. • Restart engine and check timing while in SELF-TEST. You have 2 minutes from the time the last code is outputted to check SELF-TEST timing. • Correct SELF-TEST timing equals base plus 20° BTDC ± 3° (see VECI decal for correct base timing). EXAMPLE: If base timing is 10° BTDC then SELF-TEST timing is: 10° + 20° = 30° ± 3° therefore SELF-TEST timing is 27°-33° BTDC.	Engine stalls during timing check ▶ Timing is not base + 20° BTDC ▶ Timing is base plus 20° BTDC ▶	Go To DIAGNOSTIC BY SYMPTOM in the proper ENGINE SUPPLEMENT SECTION. Go To Pinpoint Test Step P1. Go To QUICK TEST Step 5.0.

QUICK TEST: Engine Running Self-Test

5.0

A	CODE OUTPUT

NOTE: If engine is a no start go directly to Pinpoint Test Step A1. If engine stalls go directly to Diagnostic By Symptom in the proper engine supplement section.

- Deactivate SELF-TEST.
- Start and run engine at greater than 2000 RPM for 2 minutes. This warms up the EGO sensor.
- Turn engine off, wait 10 seconds.
- Activate SELF-TEST.
- **Do not depress throttle during Self-Test unless a dynamic response code occurs.**
- Start engine. The ENGINE RUNNING SELF-TEST will progress as follows:
  - — Engine ID code. ①
  - — Run test.
  - — If a dynamic response code occurs, perform a brief WOT. ②
  - — ENGINE RUNNING service codes.
- Observe and record all service codes. One of the following outputs will occur.

NOTE: If engine stalls during Self-Test, go directly to Diagnostic By Symptom in the proper engine supplement section.

RESULTS			ACTION TO TAKE
Code Format			
Engine ID	Dynamic Response	Engine Running	
2(0)	1(0) or no dynamic response pulse	11 ▶	ENGINE RUNNING SELF-TEST indicates a pass. If the symptom was of an intermittent nature, Go To QUICK TEST STEP 6.0. If the drive symptom is currently present, Go To DIAGNOSTIC BY SYMPTOM in the proper ENGINE SUPPLEMENT SECTION. Otherwise testing is complete, EEC-IV system is OK.
2(0)	1(0) or no dynamic response pulse	ANY CODES ▶	ENGINE RUNNING SELF-TEST indicates a fault. Go To QUICK TEST STEP 5.0B.
98	No dynamic response pulse	ANY CODES ▶	Rerun QUICK TEST STEP 3.0A and ensure a pass code 11 for KEY ON, ENGINE OFF portion.
NO CODES OUTPUTTED			Repeat SELF-TEST and verify that no service codes are present, then Go To Pinpoint Test Step Q1.

①Engine ID code is equal to half the number of cylinders (a code of 2 equals a 4 cylinder engine. STAR tester adds a zero to all single digit readings, so a 20 code equals a 4 cylinder engine).

②Star displays a 10 in place of a 1 for the single digit separator code, therefore, the dynamic response code is expressed in the results column as 1(0). Some vehicles do not require a brief wot and therefore will not display a 1(0).

QUICK TEST: Engine Running Self-Test

5.0

B RESULTS AND ACTION TO TAKE

- Using the ENGINE RUNNING service codes from QUICK TEST STEP 5.0A, follow the instructions in the ACTION TO TAKE column in this step.
- When more than one service code is received, always start service with the first code received.
- Whenever a repair is made, REPEAT QUICK TEST!

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RESULTS ▶	ACTION TO TAKE
Engine Running Service Codes	**2.3L EFI TURBO**
12 GO to Pinpoint Step ▶	KE1
13 GO to Pinpoint Step ▶	KE10
21 GO to Pinpoint Step ▶	DE1
22 GO to Pinpoint Step ▶	DF1
23 GO to Pinpoint Step ▶	DH1
24 GO to Pinpoint Step ▶	DA1
25 GO to Pinpoint Step ▶	DG1
26 GO to Pinpoint Step ▶	DK1
34 GO to Pinpoint Step ▶	KA1
41 GO to Pinpoint Step ▶	HA11
42 GO to Pinpoint Step ▶	HA8
73 GO to Pinpoint Step ▶	DH20
76 GO to Pinpoint Step ▶	DK30
77 GO to Pinpoint Step ▶	M1
99 GO to Pinpoint Step ▶	ISC HAS NOT LEARNED YET. RERUN QUICK TEST STEPS 3.0 THRU 5.0
No Codes/Code Not Listed	GO to Pinpoint Test Step Q1

QUICK TEST: Continuous Self-Test

6.0

TEST STEP	RESULT ▶	ACTION TO TAKE
A CONTINUOUS MEMORY CODES • To ensure proper diagnosis of CONTINUOUS MEMORY codes, QUICK TEST STEPS 1.0 through 5.0 must be successfully completed. • Do the results of both KEY ON, ENGINE OFF and ENGINE RUNNING SELF-TEST result in a pass code 11?	Yes ▶ No ▶	Go To **6.0B**. Return to Step 1.0 of QUICK TEST and make the necessary repairs indicated in QUICK TEST STEPS 3.0 and 5.0 before continuing.
B CLEAR CONTINUOUS MEMORY CODES • Prepare the vehicle for KEY ON, ENGINE OFF QUICK TEST per steps 1.0, 2.0, and 3.0. • Perform KEY ON, ENGINE OFF SELF-TEST. When the service codes begin, exit the self-test program (via unlatching STAR or removing the jumper wire from STI to Signal Return). Exiting QUICK TEST during code output will clear all codes stored in the CONTINUOUS MEMORY. • Repeat KEY ON, ENGINE OFF SELF-TEST. • Does KEY ON, ENGINE OFF SELF-TEST output 11-10-11?	Yes ▶ No ▶	Go To **6.0C**. Check STI circuit for short to ground. Repair as necessary. Repeat Step **6.0B**.
C DETERMINE CODES TO BE TESTED • Refer to CONTINUOUS MEMORY CODES recorded in QUICK TEST STEP 3.0A. • Have any of the codes been repaired either in KEY ON, ENGINE OFF or ENGINE RUNNING SELF-TESTS?	Yes ▶ No ▶	Disregard codes already serviced. For remaining codes, Go To **6.0D**. Go To **6.0D**.

QUICK TEST: Continuous Self-Test

6.0

D	TEST RESULTS AND ACTION TO TAKE

- YOU SHOULD NOT BE HERE UNLESS ALL PREVIOUS QUICK TEST STEPS HAVE BEEN SUCCESSFULLY COMPLETED!
- Verify proper test equipment hook up per QUICK TEST STEP 2.0.
- SELF-TEST deactivated. Do not activate SELF-TEST unless instructed.
- Using the service codes determined in STEP 6.0C, follow the action to take instructions. (While in the appropriate PINPOINT TEST, one or both of the continuous monitor modes described below may have to be used to find the intermittent fault.)

CONTINUOUS MONITOR (WIGGLE) MODES

- KEY ON ENGINE OFF
  With SELF-TEST deactivated, turn the ignition key to the ON position. You are now in the continuous monitor mode (wiggle test). STO will be activated whenever a fault is detected. A fault is indicated when the STAR LED turns off or the VOM deflection is 10.5V or greater.
- ENGINE RUNNING
  Activate SELF-TEST and perform ENGINE RUNNING QUICK TEST. After service code output has been completed do not turn engine off or deactivate SELF-TEST. Approximately 2 minutes after code 11 has been outputted the system will enter and remain in continuous monitor mode until SELF-TEST is deactivated or the engine is turned off. STO will be activated whenever a fault is detected. A fault is indicated the same way as KEY ON ENGINE OFF.
- Refer to the appendix for a detailed description of the continuous monitor (wiggle test).

QUICK TEST: Continuous Self-Test

6.0

MERKUR XR4Ti

RESULTS ▶		ACTION TO TAKE
Continuous Memory Service Codes	2.3L EFI TURBO	
14 GO to Pinpoint Step ▶	Y1	
18 GO to Pinpoint Step ▶	N1	
21 GO to Pinpoint Step ▶	DE90	
22 GO to Pinpoint Step ▶	DF90	
51 GO to Pinpoint Step ▶	DE91	
53 GO to Pinpoint Step ▶	DH90	
54 GO to Pinpoint Step ▶	DA90	
56 GO to Pinpoint Step ▶	DK90	
61 GO to Pinpoint Step ▶	DE94	
63 GO to Pinpoint Step ▶	DH94	
64 GO to Pinpoint Step ▶	DA93	
66 GO to Pinpoint Step ▶	DK93	
No Codes/Code Not Listed		GO to Pinpoint Test Step Q1

APPENDIX: Self-Test Description

SELF-TEST DESCRIPTION

The Self-Test is divided into three specialized tests: Key On, Engine Off, Engine Running, and Continuous memory. The Self-Test is not a conclusive test by itself, but is used as a part of the functional Quick-Test diagnostic procedure. The processor stores the Self-Test program in its permanent memory. When activated, it checks the EEC-IV system by testing its memory integrity and processing capability, and verifies that various sensors and actuators are connected and operating properly.

The Key On, Engine Off and Engine Running tests are functional tests which only detect faults present at the time of the Self-Test. Continuous testing is an ongoing test that stores fault information for retrieval at a later time (during the Self-Test).

Key On, Engine Off

At this time, a test of the EEC-IV system is conducted with power applied and engine at rest.

For Self-Test to detect errors in this test the fault must be present at the time of testing. For intermittents, refer to Continuous Memory Codes.

Separator Pulse

A single 1/2 second separator pulse is issued 6-9 seconds after the last Functional Test code (Key On, Engine Off only). Then 6-9 seconds after the single 1/2 second separator pulse, the continuous codes will be issued. Refer to the example below:

NOTE: The separator code and continuous memory codes follow Key On, Engine Off testing codes ONLY.

Continuous Memory Codes

Continuous memory codes are issued as a result of information stored during continuous monitor testing, while the vehicle was in normal operation. These codes are displayed only during the Key On, Engine Off testing and after the separator code. These codes should be used for diagnosis only when Key On, Engine Off and Engine Running Self-Tests result in code 11 and all Quick Test steps 1.0 through 5.0 have been successfully completed.

Engine Running Test

At this time, a test of the EEC-IV system is conducted with the engine running. The sensors are checked under actual operating conditions and at normal operating temperatures. The actuators are exercised and checked for corresponding results.

Engine Identification Codes (ID Codes)

Engine ID codes are issued at the beginning of the engine running test and are one-digit numbers represented by the number of pulses sent out. The engine ID code is equal to 1/2 the number of engine cylinder (i.e. 2 pulses = 4 cylinders). These codes are used to verify the proper processor is installed and that the Self-Test has been entered.

Dynamic Response Check

The dynamic response check verifies the movement of the TP, VAF, and MAP sensors during the brief Wide Open Throttle (WOT) performed during the Engine Running Test. The signal for the operator to perform the brief WOT is a single pulse or 10 code on the STAR.

APPENDIX: Diagnostic Aids

OUTPUT STATE CHECK

The output state check aids in servicing output actuators associated with the EEC-IV system. It enables the technician to energize and de-energize most of the system output actuators (turn EGR solenoid and Self-Test Output (STO) On and Off) on command. This mode is entered after all codes have been received from Key On, Engine Off and Continuous Testing. At this time, leave Self-Test activated and depress the throttle. Each time the throttle is depressed the output actuators will change state (On to Off or Off to On).

- Enter Self-Test.
- Code Output Ends.
- Do Brief WOT.
- Output Actuators Actuated.
- Next Brief WOT.
- Output Actuators Deactivated.

APPENDIX: Continuous Self-Test

The Continuous Memory service codes are separated from the Quick Test Key On, Engine Off codes by a single separator pulse, Figure 5.

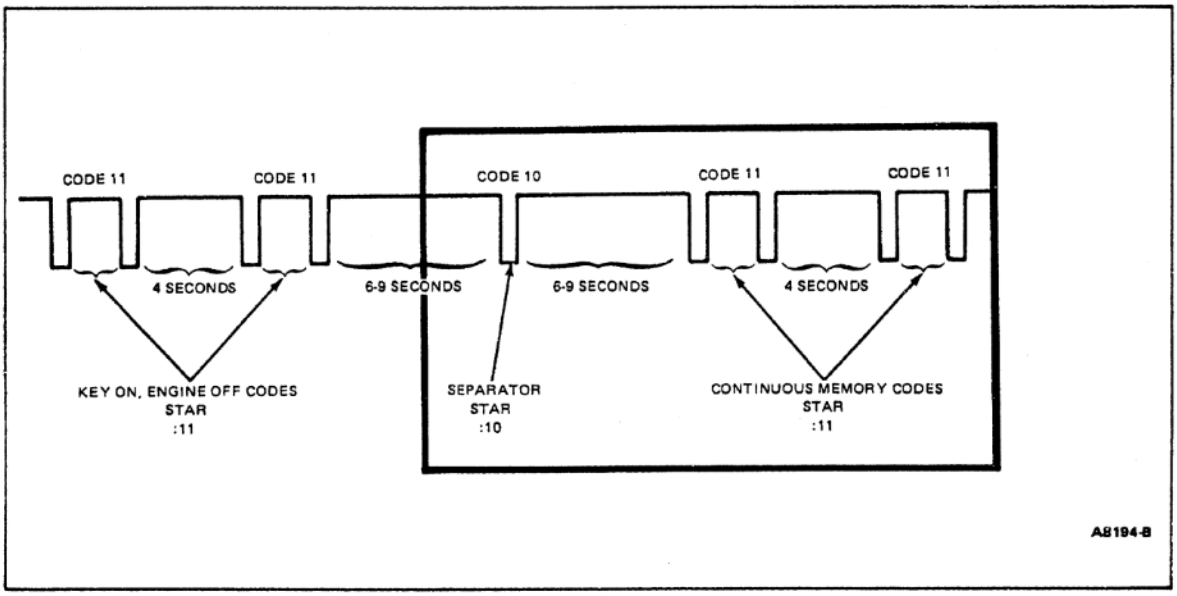


Figure 5 Continuous Memory Self-Test Output Code Format

The Continuous Memory codes should never be used for Diagnosis until the Key On, Engine Off and Engine Running Tests result in a pass code 11.

The service codes that were displayed (repeated) in both the Continuous Memory and Engine Running Test are considered repaired. The unique service code(s) displayed only in Continuous Memory are considered the intermittent service codes.

During this mode of testing we continuously monitor inputs to processor for opens and shorts. The continuous memory codes must be retrieved within twenty engine temperature warm up cycles. On the twenty-first Engine Temperature cycle the service code will be automatically erased. The continuous memory code can also be erased by deactivating Quick Test, while the service codes are being outputted.

Continuous Monitor Test

This test is intended as an aid in diagnosing intermittent failures in the sensor input circuits. The Self-Test output is energized whenever the continuous memory mode senses a fault and de-energized when the system is OK.

- Connect a VOM/STAR to the Self-Test output.

APPENDIX: Continuous Self-Test (Continued)

- **Key On, Engine Off** Continuous Monitor Test, (Wiggle).

  To enter this mode, "verify" Self-Test is not activated and then turn the key to run. Self-Test output will be activated whenever a continuous fault is detected and if the duration is long enough, a fault code will be stored.

- **Engine Running Continuous** Monitor Test, (Wiggle).

  This mode of testing is entered approximately 2 minutes after the service codes from the Engine Running portion of Quick Test (Step 5.0) because the engine running test can be entered only once per ignition cycle. An alternate quick method (eliminates waiting for Self-Test to complete its cycle) is to enter the running test, exit, and re-enter (do not shut the engine off). This will put you in the Engine Running Continuous Monitor (Wiggle) Test.

  The Continuous Monitor (Wiggle) Test will allow the technician to enter this mode of Self-Test and to attempt to re-create the intermittent failure (tap, move, wiggle the harness and/or the suspected sensor).

  If the VOM/STAR indicates a fault (short or open) the corresponding service code will be stored. Now with the knowledge of the affected circuits, a close check of the harness and associated connectors can be made.

  NOTE: Remember to keep your eyes on the VOM/STAR for any change which will indicate where the intermittent is located.

EXAMPLE: How to Use the Continuous Monitor Test (Systematically)

If a service code 51 was displayed: Engine Coolant Temperature Sensor:

- Visually inspect the sensor **very closely.**
- Enter Continuous Monitor test.
- Lightly TAP on the sensor.
- Push/pull on the sensor harness connector (do not disconnect, yet).
- Test and Wiggle (shake) harness vigorously working from the sensor connector toward the dash panel and from the dash panel to the processor in short sections.
- If VOM has not given a positive indication of an intermittent, disconnect the sensor from the harness as carefully as possible. Remove terminals from the connector. Visually inspect terminals at both ends for corrosion, bad crimps, improperly seated terminals, etc.
- Reconnect after inspection.
- Disconnect processor from harness as carefully as possible.
- Inspect terminals.
- Only remove terminals associated with the sensor being inspected.
- If the VOM does not give a positive intermittent indication, reconnect the connector and erase the Continuous Test service codes.
- To erase the continuous service codes:
  - — Initiate Key On, Engine Off Self-Test.
  - — Remove jumper from the Self-Test input terminal as soon as the **first** service code is received (even if an "11" is the first code).
  - — Rerun Self-Test with jumper to verify services have been erased.

APPENDIX: Code Output Format

SERVICE CODES

The EEC-IV system communicates service information to the outside world by way of the Self-Test service codes. These service codes are two-digit numbers representing the results of Self-Test.

The service codes are transmitted on the Self-Test output (found in the Self-Test connector) in the form of timed pulses, and read by the technician on a voltmeter or on the STAR tester.

SELF-TEST OUTPUT CODE FORMAT* KEY ON, ENGINE OFF

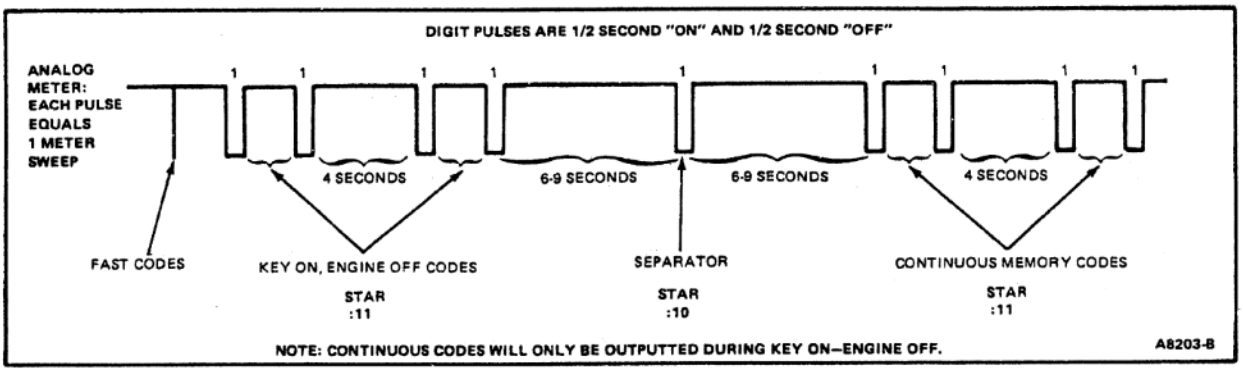


Figure 1 Key On, Engine Off Self-Test Output Code Format

SELF-TEST OUTPUT CODE FORMAT* ENGINE RUNNING

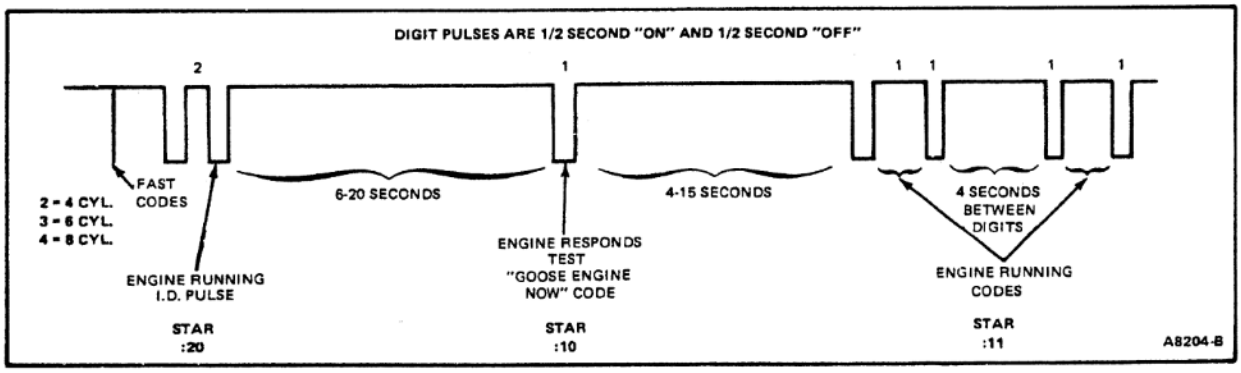


Figure 2 Engine Running Self-Test Output Code Format

Fast Codes

Fast codes are issued prior to regular service codes. These codes contain the identical information as the regular service codes but are transmitted at 100 times the normal rate. These codes are interpreted by special equipment at the Body and Assembly Division. They serve no purpose for the field.

For this reason the STAR has been designed to disregard these codes. Some meters in service detect these codes as a short burst of information (slight meter deflection).

APPENDIX: Self-Test With Analog Voltmeter

Reading Codes—Analog Voltmeter

When a service code is reported on the analog voltmeter for a function test, it will represent itself as a pulsing or sweeping movement of the voltmeter's needle across the dial face of the voltmeter (Figure 3). Therefore, a single-digit number of three will be reported by three needle pulses (sweeps). However, as previously stated, a service code is represented by a two-digit number, such as 2-3. As a result, the Self-Tests service code of 2-3 will appear on the voltmeter as two needle pulses (sweeps), then, after a two-second pause, the needle will pulse (sweep) three times.

The continuous memory codes are separated from the functional codes by a six-second delay, a single half-second sweep, and another six-second delay. They are produced on the voltmeter in the same manner as the functional codes.

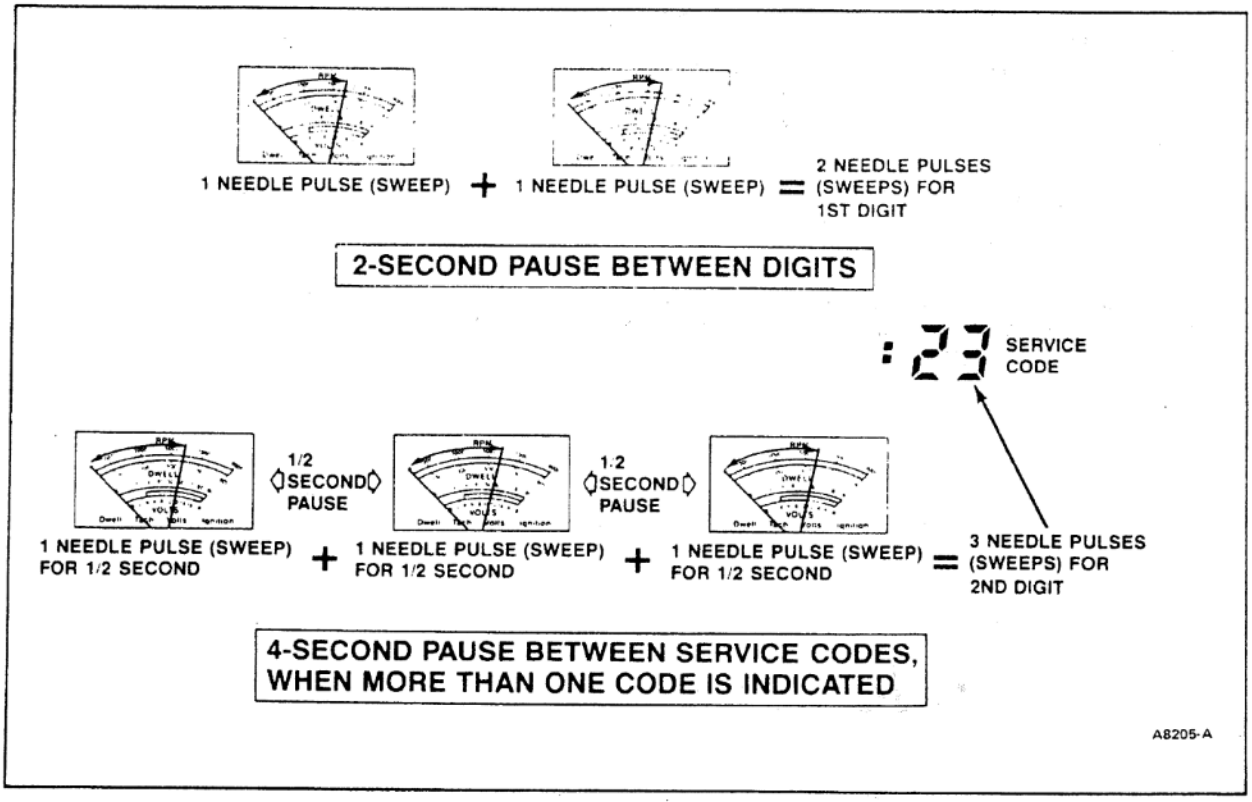


Figure 3 Analog Voltmeter Functional Service Code

APPENDIX: Self-Test With STAR Tester

Reading Codes—Self-Test Automatic Readout (STAR) Rotunda Model 007-00004 or Equivalent

After hooking up the STAR tester and turning on its power switch, the tester will run a display check and the numerals 88 will begin to flash in the display window (Figure 4). A steady 00 will then appear to signify that the STAR tester is ready to start the Self-Test and receive the test's service codes.

To receive the service codes, press the pushbutton at the front of the STAR tester. The button will latch down, and a colon will appear in the display window in front of the 00 numerals. The colon **must** be displayed to receive the service codes.

If for any reason the technician wishes to clear the display window during the Self-Test, he must turn off the vehicle's engine, press the tester's pushbutton once to unlatch it (colon will disappear), then press the button again to latch down the button (colon will appear again). Every time the STAR tester is turned off, the low battery indicator (LO BAT) should show briefly at the upper left corner of the tester's display window. If the LO BAT indicator shows steadily at any other time during the operation of the STAR tester with any service code, turn its power switch to Off and replace the 9-volt battery in the tester.

The STAR tester will display the last service code received, even after disconnecting it from the vehicle. It will hold the service code on the display until the power is turned off or the pushbutton is unlatched and relatched.

WARNING: Anyone who departs from the instructions provided in this publication must first establish that he compromises neither his personal safety nor the vehicle integrity by his choice of methods, tools, or parts.

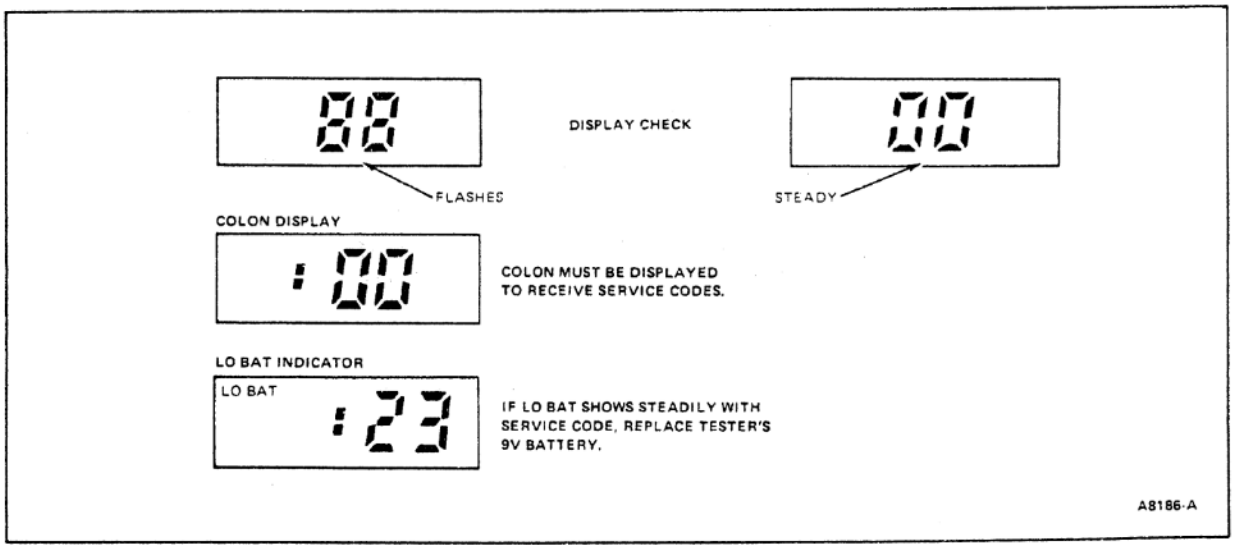
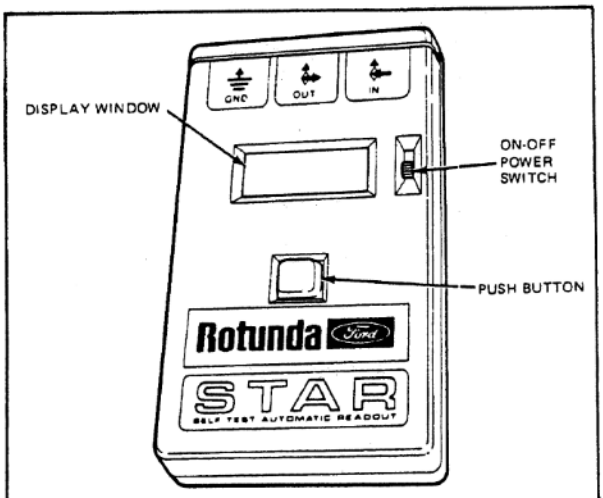


Figure 4 Self-Test Output Code Format

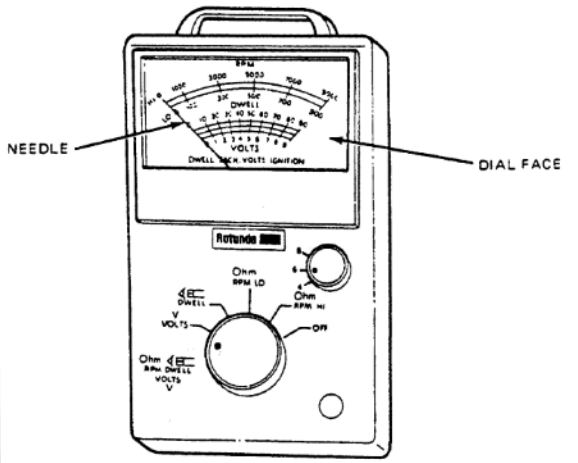
APPENDIX: Test Equipment

EQUIPMENT REQUIRED:

- Rotunda Self-Test Automatic Readout (STAR), No. 007-00004 with cable assembly No. 007-00010. Refer to STAR operation.
- Analog volt-ohmmeter, 0 to 20v DC, (alternate to STAR).

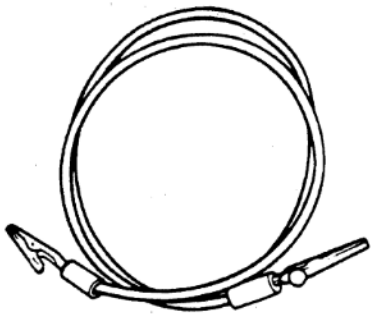


Automatic Readout (STAR) Tester

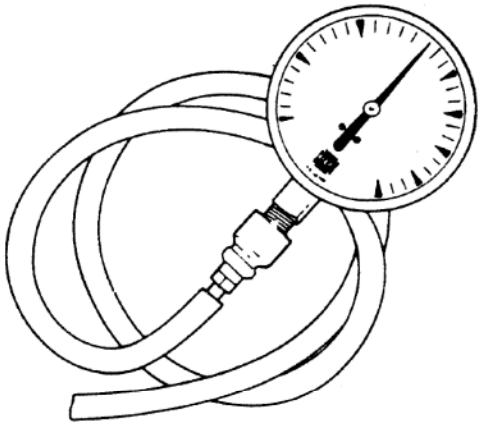


Analog Voltmeter

- Jumper wire.
- Vacuum gauge, Rotunda 059-00008 or equivalent. Range 0-30 in. Hg. Resolution 1 in. Hg.



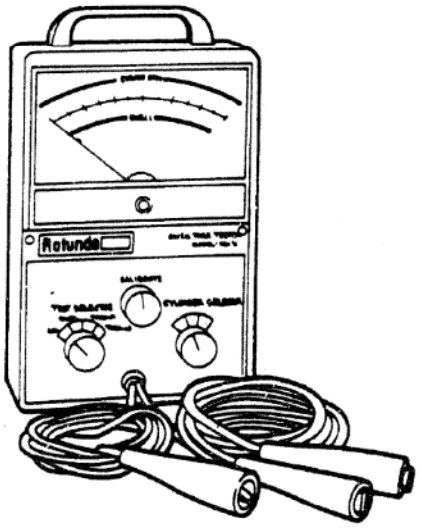
Jumper Wire



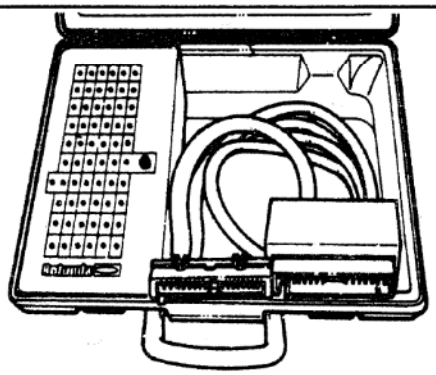
Vacuum Gauge

APPENDIX: Test Equipment (Continued)

- Tachometer, Rotunda No. 059-00010 or equivalent. Range 0-6,000 rpm. Accuracy ± 40 rpm. Resolution 20 rpm.
- Breakout Box, Rotunda 014-00322, Special Service Tool T83L-50-EEC-IV or equivalent.

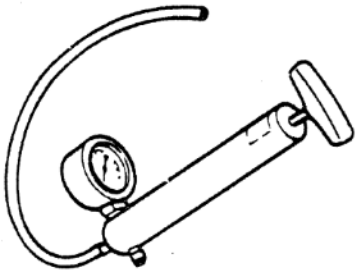


Tachometer

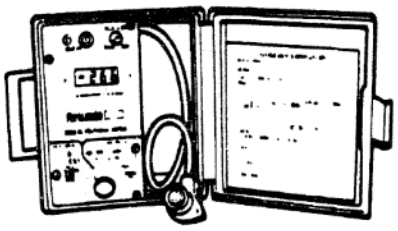


Breakout Box

- Vacuum pump, Rotunda No. 021-00014 or equivalent. Range 0-30 in. Hg.
- Digital volt-ohmmeter, Rotunda No. 014-00407 or equivalent. Input impedance 10 Megaohm minimum.



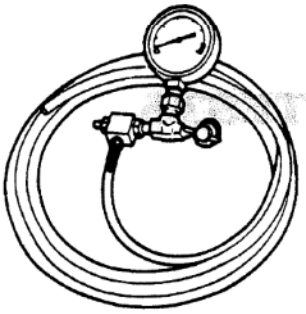
Vacuum Pump



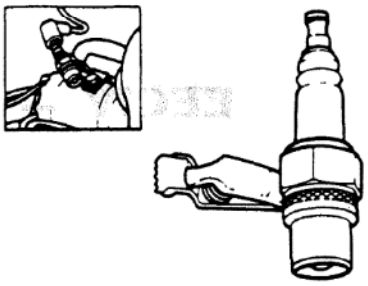
Digital Volt-Ohmmeter

APPENDIX: Test Equipment (Continued)

- Electronic Fuel Injection Pressure Gauge EFI/CFI only, Tool T80L-9974-A or equivalent. (Use instructions. For specific applications, refer to Shop Manual Group 24.)
- Spark tester (optional modified spark plug with side electrode removed). Tool D81P-6666-A or equivalent.

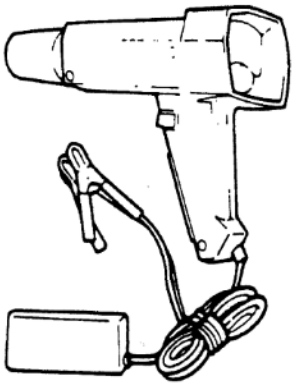


EFI Pressure Gauge

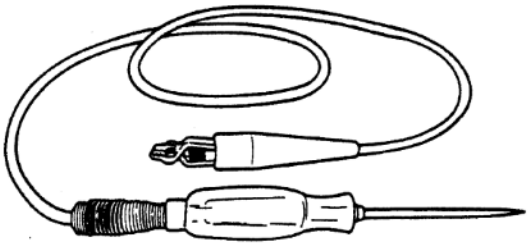


Spark Tester

- Timing light, Rotunda model 059-00006 or equivalent.
- Non-powered Test lamp.



Timing Light



Non-Powered Test-Lamp

EECIV — PINPOINT TESTS

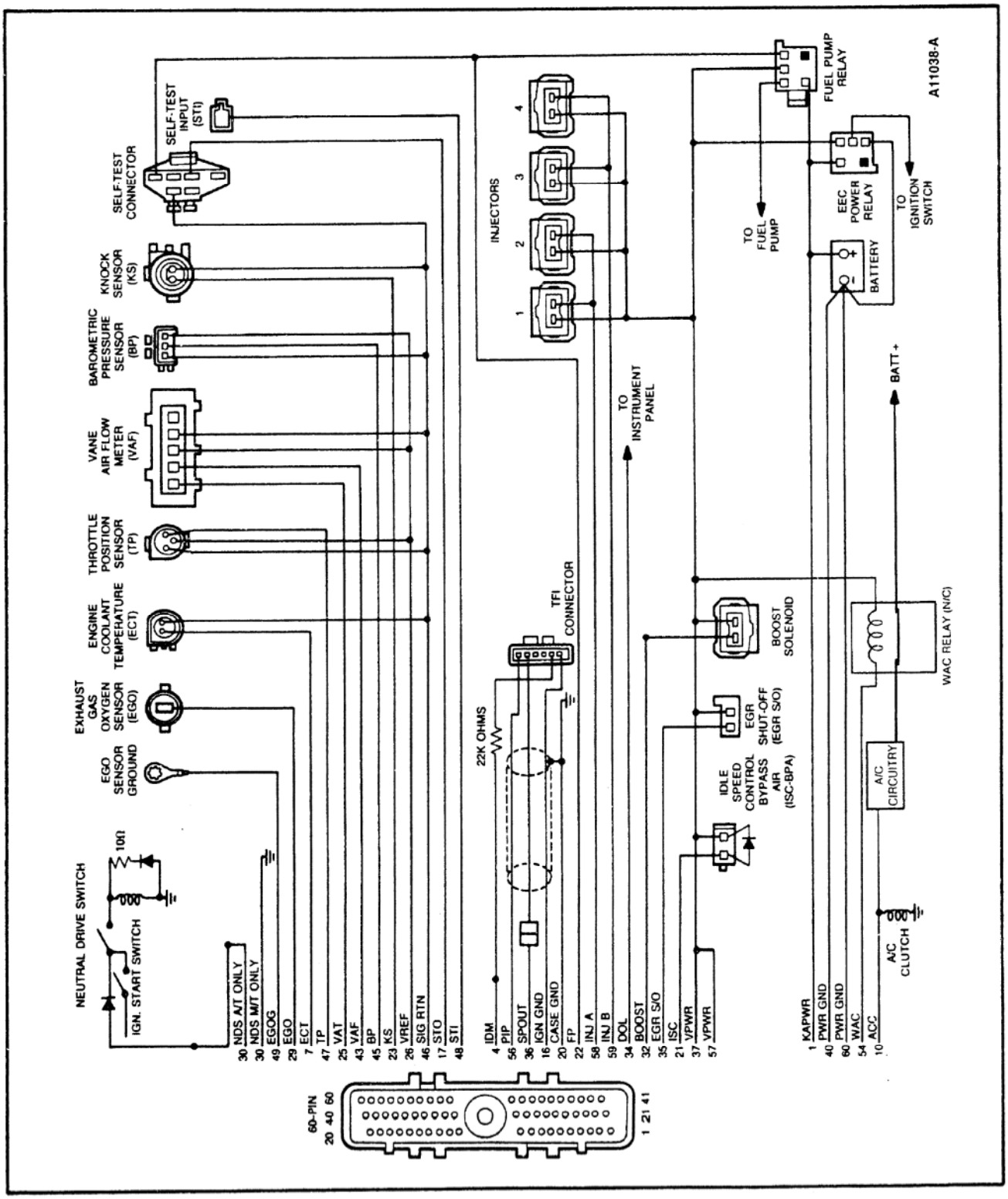
Electronic Diagnostic By Symptom

2.3L EFI TURBO

SYMPTOM	RESULT	ACTION TO TAKE
7.0 DIAGNOSTICS BY SYMPTOM		
• Engine stalls. • Stalls in Self-Test. • Runs rough. • Misses.	Always Rich/Lean. ▶	• GO to Pinpoint Test Step **S1**. • BP test, GO to Pinpoint Test Step **DF20**. • Idle speed control, GO to Pinpoint Test Step **KE1**. • Poor power/ground connections. • Ignition system distributor cap, rotor, wires, coil, plugs. • Short to Ground, Go to Pinpoint Test Step **J9**. • Base engine valves cam timing, compression etc.
• Detonation/spark knock.		GO to Pinpoint Test Step **DG1**.
• High idle speeds on each restart may be accompanied by detonation for up to 3-5 minutes after a restart.		GO to Pinpoint Test Step **DG1**.
• Lack of fast idle assist with A/C On.		GO to Pinpoint Test Step **FA1**.
• Gasoline fumes under hood.		GO to Pinpoint Test Step **KD1**.
• A/C does not cut-off under WOT conditions.		GO to Pinpoint Test Step **KM1**.
• Poor performance, sluggish detonation.	Boost control not functioning properly ▶	GO to Pinpoint Test Step **KN1**.

Electrical Schematic

2.3L EFI TURBO



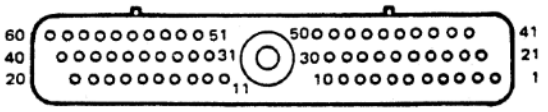
EEC-IV Module Connector Pin Usage

2.3L EFI TURBO

MERKUR XR4Ti

Pin	Circuit	Wire Color	Application	Abbreviations
1	37	Y	Keep Alive Power	KAPWR
4	11	DG/Y	Ignition Diagnostic Monitor	IDM
7	354	LG/Y	Engine Coolant Temperature	ECT
10	347	BK/Y	A/C Clutch	ACC
16	259	BK/O	Ignition Ground	IGN. GND.
17	201	Y/BK	Self-Test Output	STO
20	57	BK	Case Ground	CSE. GND.
21	67	GY/W	Idle Speed Control	ISC
22	97	T/LG	Fuel Pump Control	FP
23	310	Y/R	Knock Sensor	KS
25	357	LG/P	Vane Air Temperature	VAT
26	351	O/W	Voltage Reference	V. REF.
29	94	DG/P	Exhaust Gas Oxygen Sensor	EGO
30	376	Y/R	Neutral Drive Switch	NDS
32	544	P	Boost Control	BOOST
34	39	LE/P	Data Output Link	DOL
35	362	Y	EGR Shut-Off	EGR S/O
36	324	Y/LG	Spark Output	SPOUT
37	361	R	Vehicle Power	V PWR
40	57	BK	Battery Ground	BATT. GND.
43	200	W/BK	Vane Air Flow	VAF
45	358	LG/BK	Barometric Pressure	BP
46	359	BK/W	Signal Return	SIG. RET.
47	355	DG/LG	Throttle Position Sensor	T.P.
48	100	W-R-D	Self-Test Input	STI
49	89	O	EGO Ground	EGO GND.
54	208	O/LB	W.O.T. A/C Cut-Off	WAC
56	349	DB	Profile Ignition Pick-Up	PIP
57	361	R	Vehicle Power	V PWR
58	95	T/R	Injector Bank 1	INJ 1
59	96	T/O	Injector Bank 2	INJ 2
60	57	BK	Battery Ground	BATT. GND.

Pin locations given for reference only. Probing 60 pin connector with DVOM probe will result in permanent damage to the pin connectors. Always probe as directed, using the Breakout Box.



CA11039-A

Pinpoint Tests

INSTRUCTIONS FOR USING THE PINPOINT TESTS

- Do not run any of the following Pinpoint Tests unless you are so instructed by the Quick Test. Each Pinpoint Test assumes that a fault has been detected in the system with direction to enter a specific repair routine. Doing any Pinpoint Test without direction from Quick Test may produce incorrect results and replacement of Non-Defective components.
- Correct test results for Quick Test are dependent on the proper operation of related non-EEC components/systems. It may be necessary to correct any defects in these areas before EEC will pass the Quick Test. Refer to the Diagnostic Routines, Section 2 for service.
- Do not replace any parts unless the test result indicates they should be replaced.
- When more than one service code is received, always start service with the first code received.
- Do not measure voltage or resistance at the processor or connect any test lights to it, unless otherwise specified.
- Isolate both ends of a circuit, and turn key Off whenever checking for shorts or continuity, unless specified.
- Disconnect solenoids and switches from the harness before measuring for continuity, resistance, or energizing by way of 12-volt source.
- In using the Pinpoint Tests, follow each Step in order, starting from the first Step in the appropriate test. Follow each Step until the fault is found.
- After completing any repairs to the EEC system, verify all components are properly reconnected and repeat the functional test (Retest).
- An open is defined as any resistance reading greater than 5 ohms unless otherwise specified.
- A short is defined as any resistance reading less than 10,000 ohms to ground, unless otherwise specified.

The standard Ford color abbreviations are:

BK	**Black**	**N**	**Natural**
BL	**Blue**	**O**	**Orange**
BR	**Brown**	**PK**	**Pink**
DB	**Dark Blue**	**P**	**Purple**
DG	**Dark Green**	**R**	**Red**
GY	**Gray**	**T**	**Tan**
GR	**Green**	**W**	**White**
LB	**Light Blue**	**Y**	**Yellow**
LG	**Light Green**		

Where two colors are shown for a wire, the first color is the basic color of the wire. The second color is the dot, hash, or stripe marking. If **D** or **H** is given, the second color is dots or hash marks. If there is no letter after the second color, the wire has a stripe.

For example:

BR/O is a brown wire with an orange stripe.

R/Y D is a red wire with yellow dots.

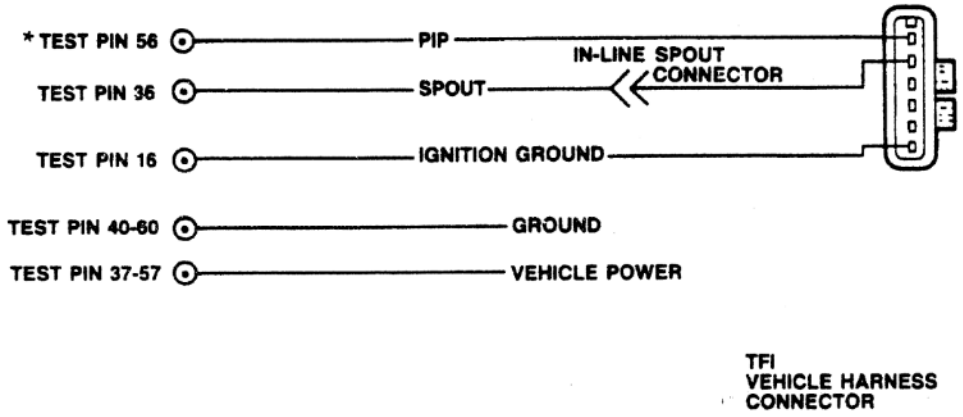
BK/W H is a black wire with white hash marks.

Pinpoint Test Index

PINPOINT TEST LETTER	PINPOINT TEST TITLE	PAGE NUMBER
A	EEC IV No Start	4-31
B	Vehicle Battery	4-37
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	SENSOR INPUTS	
DA	Vane Air Temperature Sensor (VAT)	4-45
DE	Engine Coolant Temperature Sensor (ECT)	4-57
DF	Manifold Absolute Pressure (MAP)/Barometric Pressure (BP) Sensor	4-58
DG	Knock Sensor	4-65
DH	Throttle Position Sensor (TPS)	4-68
DK	Vane Air Flow Sensor (VAF)	4-75
	ADDITIONAL INPUTS	
FA	Neutral Drive Switch A/C Input	4-82
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HA	Fuel Control—EFI	4-89
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KE	Idle Speed Control (By-Pass Air)	4-106
M	Dynamic Response Test	4-118
N	Ignition Diagnostic Monitor (IDM)	4-120
Q	No Codes/Codes Not Listed	4-126
Y	Erratic Ignition	4-116

EEC IV No Start	Pinpoint Test	A

A



*TEST PIN LOCATED ON BREAKOUT BOX.
ALL CONNECTIONS VIEWED INTO MATING SURFACE.

NOTE: WHEN BREAKOUT BOX IS INSTALLED, ENSURE THAT TIMING SWITCH IS IN "COMPUTED" POSITION UNLESS OTHERWISE NOTED.

STOP-WARNING

You should enter this Pinpoint Test only when Steps 1.0 through 3.0 have been successfully completed and the engine is still a no start. This Pinpoint Test will not diagnose ignition system problems.

To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

- Fuel: quantity and quality
- Ignition: general condition, moisture, cracks, damage, etc.
- Engine: internal, valves, timing belt, camshaft.
- Starter and battery circuit

This Pinpoint Test is intended to diagnose only the following:

- Spark (as related to EEC-IV).
- Circuits: pip, spout, ignition ground, vehicle power.

EEC IV No Start	Pinpoint Test	A

WARNING: Stop this test at the first sign of a fuel leak and service as required.
CAUTION: No open flame — No smoking during fuel delivery checks.

TEST STEP	RESULT ▶	ACTION TO TAKE
A1 ATTEMPT TO START ENGINE		
	Engine cranks, but does not start, or stalls out ▶	GO to **A2**.
	Engine does not crank ▶	REFER to Shop Manual, Group 28.
A2 CHECK FOR VREF AT THROTTLE POSITION SENSOR		
• Key Off, wait 10 seconds. • DVOM on 20V scale. • Disconnect TP sensor. • Key On, Engine Off. • Measure voltage at the TP vehicle harness connector between VREF and signal return. **NOTE: Refer to electrical schematic in appropriate engine supplement section for connector pin orientation.**	Less than 4.0V or greater than 6.0V ▶	GO to Pinpoint Test Step **C1**.
	4.0V to 6.0V ▶	RECONNECT TP sensor. GO to **A3**.
A3 CHECK FOR SPARK AT PLUGS		
• Disconnect the spark plug wire to any accessible cylinder. • Connect spark tester between spark plug wire and engine ground. • Crank engine and check for spark. • Reconnect the spark plug wire to the spark plug.	Spark ▶	GO to **A13**.
	No spark ▶	GO to **A4**.
A4 CHECK FOR SPARK AT COIL		
• Remove high tension coil wire from distributor and install spark tester. • Check for spark while cranking. • Reconnect high tension coil wire to distributor.	Spark ▶	REFER to Section 23-01, for TFI Diagnosis for cap, rotor, wires.
	No spark ▶	GO to **A5**.

EEC IV No Start	Pinpoint Test	A

TEST STEP	RESULT ▶	ACTION TO TAKE
A5 HARNESS CHECK (IGNITION GROUND) • Key Off, wait 10 seconds. • Install Breakout box. Leave processor disconnected. • DVOM on 200 ohm scale. • Disconnect TFI. • Measure resistance between test Pin 16 at the Breakout box and TFI harness connector ignition ground.	Less than 5 ohms ▶ 5 ohms or greater ▶	GO to **A6**. SERVICE harness as necessary. RERUN Quick Test.
A6 ISOLATION OF PROBLEM TO SPOUT CIRCUIT • Breakout box installed. • Connect TFI. • Connect processor. • Timing switch to "Dist" position on Breakout box. • Attempt to start vehicle. • Does the vehicle start?	Yes ▶ No ▶	GO to **A10**. GO to **A7**.
A7 SPOUT SIGNAL CHECK • Breakout box installed. • Timing switch to "Computed" position on Breakout box. • DVOM on 20V scale. • Measure voltage between test Pin 36 at the Breakout box and chassis ground, during crank.	Less than 3.0V or greater than 6.0V ▶ Between 3.0V and 6.0V ▶	GO to **A8**. EEC OK, REFER to Section 15, for TFI diagnosis.
A8 CHECK SPOUT FOR SHORTS • Key Off, wait 10 seconds. • Breakout box installed. • Disconnect processor. • Disconnect TFI. • DVOM on 200,000 ohm scale. • Measure resistance between test Pin 36 and test Pins 16, 20, 26, 40, 60 (short to ground), 37, 57 (short to power) and 56 (short to pip) at the Breakout box.	All readings 10,000 ohms or greater ▶ Any reading less than 10,000 ohms ▶	GO to **A9**. SERVICE short in harness. RERUN Quick Test if vehicle does not start. GO to **A9**.

EEC IV No Start	Pinpoint Test	A

TEST STEP	RESULT ▶	ACTION TO TAKE
A9 ISOLATE SHORT(S) IN PROCESSOR		
• Key Off, wait 10 seconds. • Breakout box installed. • Reconnect processor. • TFI disconnected. • DVOM on 200 ohm scale. • Measure resistance between test Pin 36 and test Pins 37 and 57 (short to power) also, test Pins 40 and 60 (short to ground) at the Breakout box.	All readings 5.0 ohms or greater. ▶	Connect TFI. GO to **A10**.
	Any reading less than 5.0 ohms ▶	REPLACE processor. RERUN Quick Test.
A10 PIP SIGNAL CHECK		
• Breakout box installed. • DVOM to 20V scale. • Measure voltage between test Pin 56 and test Pin 16 at the Breakout box. • Crank engine, record reading.	Between 3.0V and 6.0V ▶	REMOVE Breakout box. REPLACE processor. RERUN Quick Test.
	Less than 3.0V or greater than 6.0V ▶	GO to **A11**.
A11 CONTINUITY OF PIP CIRCUIT CHECK		
• Breakout box installed. • Key Off, wait 10 seconds. • DVOM on 200 ohm scale. • Disconnect TFI. • Disconnect processor. • Measure resistance between test Pin 56 at the Breakout box and TFI harness connector PIP circuit.	Less than 5 ohms ▶	GO to **A12**.
	5 ohms or greater ▶	SERVICE open PIP circuit. RERUN Quick Test.

EEC IV No Start	Pinpoint Test	A

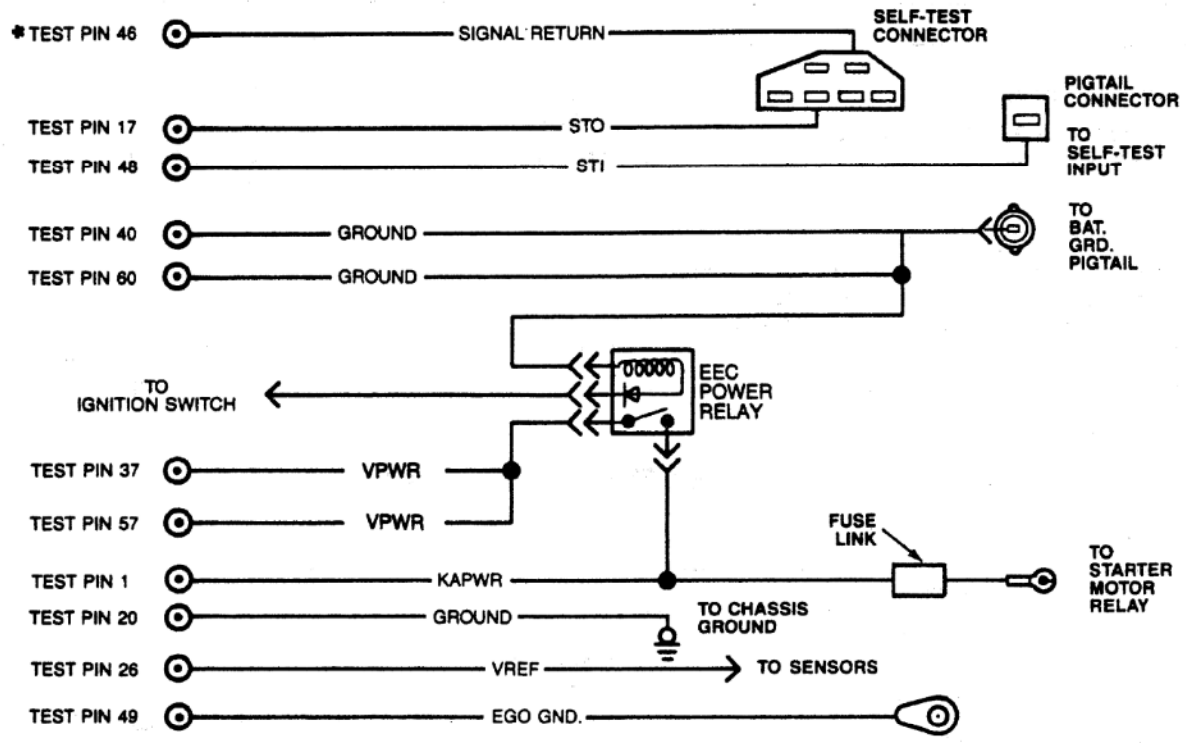
TEST STEP	RESULT ▶	ACTION TO TAKE
A12 CHECK PIP CIRCUIT FOR SHORTS		
• Breakout box installed. • Processor disconnected. • Key Off. • Disconnect TFI connector. • DVOM on 200,000 ohm scale. • Measure resistance between test Pin 56 and test Pins 16, 20, 26, 40, 60 (shorts to ground) and test Pins 37 and 57 (shorts to power) and test Pin 36 (short to spout) at the Breakout box.	Any resistance less than 10,000 ohms ▶ All resistance greater than 10,000 ohms ▶	SERVICE PIP circuit. RERUN Quick Test. REFER to Section 23 for TFI diagnosis.
A13 SPOUT SIGNAL VERIFICATION		
• Key Off, wait 10 seconds. • Disconnect processors 60 pin connector and inspect for damaged pins, corrosion, loose wires. Service as necessary. • Install Breakout box. • Processor connected. • DVOM on 20V scale. • Measure voltage between test Pin 36 at the Breakout box and chassis ground, during crank. • Ensure timing switch is in "Computed" position on Breakout box.	Between 3.0V and 6.0V ▶ Less than 3.0V or greater than 6.0V ▶	GO to **A21**. GO to **A10**.

EEC IV No Start	Pinpoint Test	A

TEST STEP	RESULT ▶	ACTION TO TAKE
A21 FUEL PUMP CHECK		
• **No smoking nearby.** • Disconnect all injector electrical connections at the injectors. • Connect pressure gauge. • Note initial pressure reading. • Observe pressure gauge as you pressurize fuel system. (Turn key to RUN for 1 second, then turn key to OFF. Wait 10 seconds. Repeat 5 times.) • Turn key Off. Wait 10 seconds. • Reconnect all injectors. **WARNING: If fuel starts leaking, turn key OFF immediately. No smoking.**	PRESSURE GAUGE READING: Increased ▶ Did not increase ▶	GO to Pinpoint Test Step S1. TURN key Off, and CONTINUE to A22.
A22 INERTIA SWITCH CHECK		
• Key Off. • Fuel pressure gauge installed. • Locate fuel pump inertia switch. Refer to Owner's Manual for location. • Push the button of inertia switch to reset to ON. **NOTE: If switch will not reset to ON, replace Inertia Switch and repeat Step A21. If switch button was on, GO to Step J1.** • Observe pressure gauge as you pressurize fuel system. (Turn key to RUN for 1 second, then turn key to OFF. Wait 10 seconds.) Repeat 5 times.	PRESSURE GAUGE READING: Increase ▶ No increase ▶	RERUN Quick Test. • GO to J1.

Vehicle Battery	Pinpoint Test	B

B



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

STOP-WARNING

You should enter this Pinpoint Test only when directed here from Pinpoint Tests C, J or P or when a continuous memory code 78 is received in Quick Test Step 6.0C.

To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

- Ignition switch.
- Battery Cables.
- Alternator.
- Voltage Regulator.
- Ground Straps.

This pinpoint test is intended to diagnose only the following:

- Processor.
- Harness circuits: Signal Return, STO, STI, Ground, VPWR, KAPWR, VREF, Ignition.
- Battery Voltage.
- Power Relay.

Vehicle Battery — Pinpoint Test B

TEST STEP	RESULT ▶	ACTION TO TAKE
B1 BATTERY VOLTAGE CHECK • Key On, Engine Off. • DVOM on 20V scale. • Measure voltage across battery terminals.	10.5V or greater ▶ Less than 10.5V ▶	GO to **B2**. SERVICE discharged battery, REFER to Group 31.
B2 BATTERY POWER GROUND CHECK • Key On, Engine Off. • Processor connected. • DVOM on 20V scale. • Measure voltage between battery negative post and Signal Return in the Self-Test connector.	Less than 0.5V ▶ 0.5V or greater ▶	GO to **B6**. GO to **B3**.
B3 GROUND FAULT ISOLATION • Breakout box installed. • Key On, Engine Off. • Processor connected. • DVOM on 20V scale. • Measure voltage between battery negative post and test Pins 40 and 60 at the Breakout box.	Both readings less than 0.5V ▶ One or both readings 0.5V or greater ▶	GO to **B4**. Circuit(s) with greater than 0.5V has high resistance or open. CORRECT faulty ground circuit. RERUN Quick Test.
B4 PROCESSOR GROUND FAULT ISOLATION • Breakout box installed. • Key Off, wait 10 seconds. • Processor connected. • DVOM on 200 ohm scale. • Measure resistance between test Pin 46 and test Pin 40 and between test Pin 46 and test Pin 60 both at the Breakout box.	Both readings less than 5 ohms ▶ One or both readings 5 ohms or greater ▶	GO to **B5**. DISCONNECT processor connector and INSPECT for corrosion, damaged pins, etc. SERVICE as necessary and RETEST. If fault is still present, REPLACE processor. RERUN Quick Test.

Vehicle Battery	Pinpoint Test	B

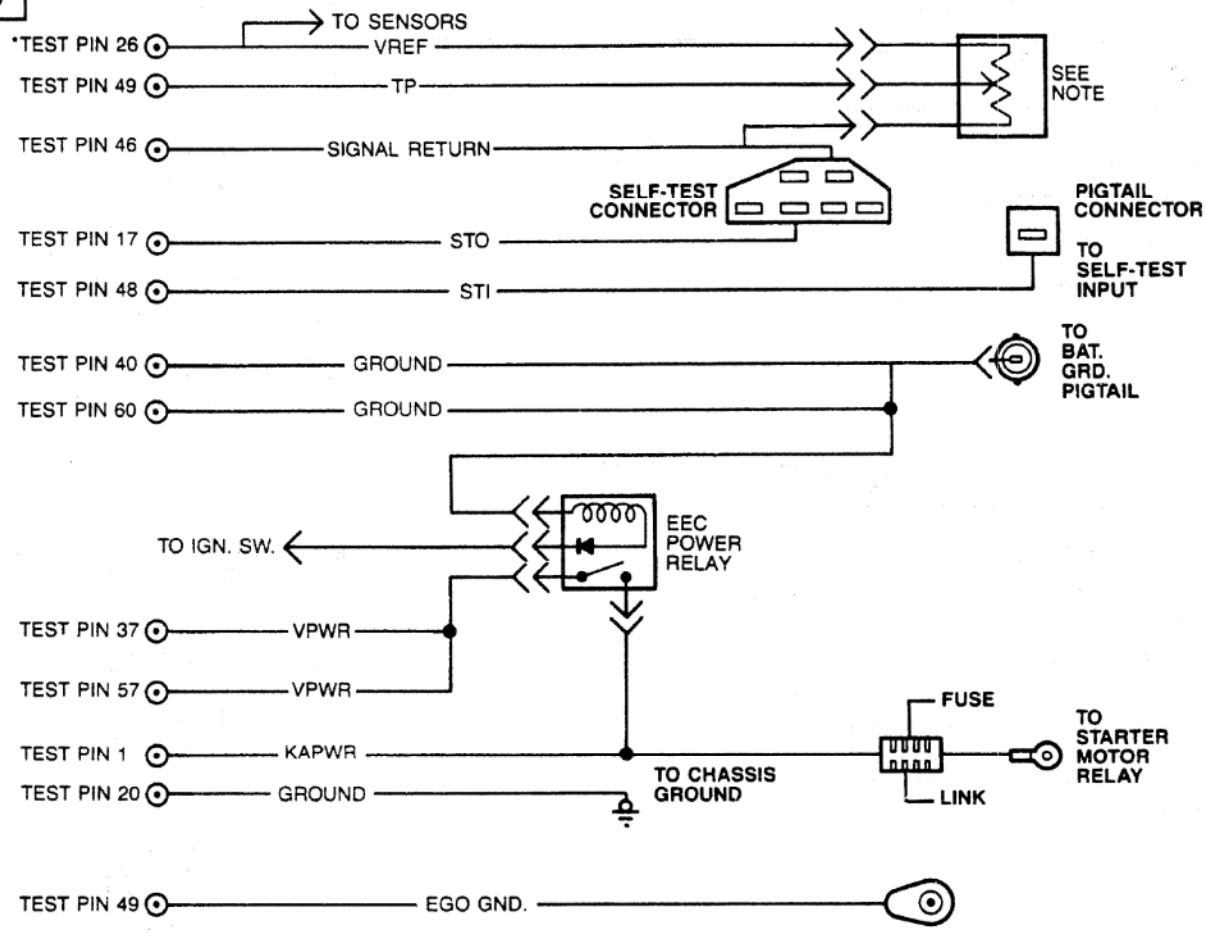
TEST STEP	RESULT ▶	ACTION TO TAKE
B5 HARNESS CHECK (SIGNAL RETURN)		
• Breakout box installed. • Key Off, wait 10 seconds. • Processor connected. • DVOM on 200 ohm scale. • Measure resistance between test Pin 46 at the Breakout box and Signal Return in the Self-Test connector.	Less than 5 ohms ▶ 5 ohms or greater ▶	System OK. RUN Quick Test. CORRECT cause of resistance in the harness Signal Return circuit. RERUN Quick Test.
B6 12 VOLT BATTERY POWER FAULT ISOLATION		
• Key On, Engine Off. • Processor connected. • DVOM on 20V scale. • Measure voltage between the battery negative post and KAPWR circuit at EEC power relay.	10.5V or greater ▶ Less than 10.5V ▶	GO to **B7**. CHECK KAPWR and VPWR circuits for shorts to ground and KAPWR circuit from power relay to battery positive post for opens. SERVICE as necessary. RERUN Quick Test.
B7 12 VOLT BATTERY POWER FAULT ISOLATION		
• Key On, Engine Off. • Processor connected. • DVOM on 20V scale. • Measure voltage between the battery negative post and Ignition circuit at EEC power relay.	10.5V or greater ▶ Less than 10.5V ▶	GO to **B8**. CHECK for open in ignition switch circuits. SERVICE as necessary. RERUN Quick Test.
B8 12 VOLT BATTERY POWER FAULT ISOLATION		
• Key On, Engine Off. • Processor connected. • DVOM on 20V scale. • Measure voltage between the battery negative post and ground circuit at EEC power relay.	Less than 0.5V ▶ 0.5V or greater ▶	GO to **B9**. SERVICE open or ground in Ground Circuit. RERUN Quick Test.

Vehicle Battery	Pinpoint Test	B

TEST STEP	RESULT ▶	ACTION TO TAKE
B9 12 VOLT BATTERY POWER FAULT ISOLATION		
• Key On, Engine Off. • Processor connected. • DVOM on 20V scale. • Measure voltage between the battery negative post and VPWR circuit at EEC power relay.	10.5V or greater ▶	SERVICE short to ground or open in VPWR circuit from EEC power relay to processor connector test Pins 37 and 57. RERUN Quick Test.
	Less than 10.5V ▶	REPLACE power relay. RERUN Quick Test.
B10 WIGGLE TEST VPWR CIRCUITS		
• Key On, Engine Off. • STAR tester or VOM hooked up to Self-Test connector. • Self-Test deactivated. • Observe STAR/VOM for fault indication as explained in Quick Test Step 6.0D. • Shake, bend and twist the EEC-IV harness from the EEC time delay power relay to the processor.	Yes ▶	SERVICE intermittent VPWR circuit. RERUN Quick Test.
	No ▶	INSPECT EEC-IV time delay power relay and harness connectors for damaged pins, corrosion, etc. SERVICE as necessary. If OK, REPLACE EEC-IV time delay relay. RERUN Quick Test.

Reference Voltage	Pinpoint Test	C

C



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

NOTE: Refer to the electrical schematic in the appropriate engine supplement section for proper connector and pin orientation.

STOP-WARNING

You should enter this Pinpoint Test only when a check for VREF has failed in the sensor Pinpoint Tests (D-Series) or Pinpoint Tests A or Q.

This pinpoint test is intended to diagnose only the following:

- Processor.
- Sensor harness circuits: Signal Return, STO, STI, Ground, VPWR, KAPWR, VREF, Ignition.

Reference Voltage | Pinpoint Test | C

TEST STEP	RESULT ▶	ACTION TO TAKE
C1 VEHICLE BATTERY POWER CIRCUIT CHECK • Breakout box installed. • Key On, Engine Off. • Processor connected. • DVOM on 20V scale. • Measure voltage between test Pin 37 at the Breakout box and Signal Return in Self-Test connector.	10.5V or greater ▶ Less than 10.5V ▶	GO to C2. GO to B1.
C2 VREF VOLTAGE CHECK • Breakout box installed. • Key On, Engine Off. • Processor connected. • DVOM on 20V scale. • Measure voltage between test Pin 26 and test Pin 46 at the Breakout box.	6.0V or greater ▶ 4.0V or less ▶ Greater than 4.0V, less than 6.0V ▶	GO to C4. GO to C5. GO to C3.
C3 CHECK VREF AND SIGNAL RETURN FOR CONTINUITY • Breakout box installed. • Disconnect 60 Pin connector. Inspect for damaged pins, corrosion, loose wires, etc. Service as necessary. • Processor disconnected. • Key Off. • DVOM on 200 ohm scale. • Measure resistance from test Pin 26 at Breakout box to VREF at vehicle harness connector of the sensor that sent you here. • Measure resistance from test Pin 46 at Breakout box to signal return at vehicle harness connector of the sensor that sent you here.	Less than 5 ohms on all readings ▶ 5 ohms or greater on any reading ▶	RECONNECT sensors. Reference voltage OK. RERUN Quick Test. SERVICE open in VREF or Signal Return. RERUN Quick Test.
C4 CHECK FOR SHORT FROM VREF TO VPWR • Key Off, wait 10 seconds. • Breakout box installed. • Disconnect processor. • Key On, Engine Off. • DVOM on 20V scale. • Measure voltage between test Pin 26 at the Breakout box and battery ground.	Less than 0.5V ▶ 0.5V or greater ▶	REPLACE processor. RERUN Quick Test. SERVICE short to battery power in EEC harness. RERUN Quick Test. If condition persists, REPLACE processor.

Reference Voltage	Pinpoint Test	C

TEST STEP	RESULT ▶	ACTION TO TAKE
C5 CHECK FOR SHORTED THROTTLE POSITION SENSOR		
• Key Off, wait 10 seconds. • Breakout box installed. • Processor connected. • Disconnect Throttle Position (TP) sensor from vehicle harness. • Key On, Engine Off. • DVOM on 20V scale. • Measure voltage between test Pin 26 and test Pin 46 at the Breakout box.	Less than 4.0V ▶ 4.0V or greater ▶	Vehicles equipped with EVP sensor, GO to **C6**. All other vehicles, GO to **C7**. REPLACE TP sensor. RERUN Quick Test.
C6 CHECK FOR SHORTED EGR VALVE POSITION (EVP) SENSOR		
• Key Off, wait 10 seconds. • Breakout box installed. • Processor connected. • Disconnect EGR valve position (EVP) sensor. • Key On, Engine Off. • DVOM on 20V scale. • Measure voltage between test Pin 26 and test Pin 46 at the Breakout box.	Less than 4.0V ▶ 4.0V or greater ▶	GO to **C7**. REPLACE EVP sensor. RERUN Quick Test.
C7 CHECK FOR SHORTED MAP/BP SENSOR		
• Key Off, wait 10 seconds. • Breakout box installed. • Processor connected. • Disconnect MAP/BP sensor. • Key On, Engine Off. • DVOM on 20V scale. • Measure voltage between test Pin 26 and test Pin 46 at the Breakout box.	Less than 4.0V ▶ 4.0V or greater ▶	Vehicles equipped with VAF sensor, GO to **C8**. All other vehicles, GO to **C9**. REPLACE MAP/BP sensor. RERUN Quick Test.

Reference Voltage	Pinpoint Test	C

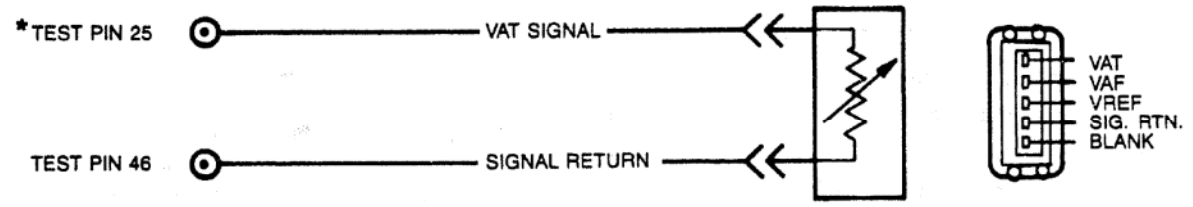
TEST STEP	RESULT ▶	ACTION TO TAKE
C8 CHECK FOR SHORTED VANE AIR METER (VAF) SENSOR		
• Key Off, wait 10 seconds. • Breakout box installed. • Processor connected. • Disconnect vane air meter (VAF) sensor. • Key On, Engine Off. • DVOM on 20V scale. • Measure voltage between test Pin 26 and test Pin 46 at the Breakout box.	Less than 4.0V ▶ 4.0V or greater ▶	GO to C9. REPLACE VAF sensor and RERUN Quick Test.
C9 SHORT TO GROUND IN VREF		
• Breakout box installed. • Processor disconnected. • Key Off, wait 10 seconds. • Disconnect TP and MAP/BP, EVP and VAF, if so equipped. • DVOM on 200 ohm scale. • Measure resistance between test Pin 26 and test Pins 20, 40, 46 and 60 at the Breakout box.	Less than 5 ohms ▶ 5 ohms or greater ▶	SERVICE short to ground. CONNECT all sensors. RERUN Quick Test. If original condition still exists, REPLACE processor. RECONNECT sensors. REPLACE processor. RERUN Quick Test.

Vane Air Temperature Sensor (VAT)

Pinpoint Test

DA

DA



NOTE: AMBIENT TEMP. MUST BE GREATER THAN 50°F TO PASS THIS TEST.

TYPICAL RESISTANCE BETWEEN TEST PINS 25 & 46	5800Ω	2700Ω	300Ω	180Ω	125Ω
AT TEMPERATURE	32°F	65°F	185°F	220°F	240°F

***TEST PIN LOCATED ON BREAKOUT BOX.**
ALL CONNECTIONS VIEWED INTO MATING SURFACE.

STOP-WARNING

You should enter this Pinpoint Test only when a service code 24, 54 or 64 is received in Quick Test Step 3.0, 5.0 or 6.0.

To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

- Test performed in unusually low (cold) or high (hot) ambient conditions.
- Ambient temperature must be greater than 50°F for this test.

This pinpoint test is intended to diagnose only the following:

- VAT sensor.
- Circuits: VAT, and Signal Return.
- Vehicle harness.
- Processor assembly.

Vane Air Temperature Sensor (VAT) | Pinpoint Test | DA

TEST STEP	RESULT ▶	ACTION TO TAKE
DA1 SERVICE CODE 24: CHECK AMBIENT TEMPERATURE		
• Ambient temperature must be greater than 50°F for this test.	Yes ▶	GO to **DA2**.
	No ▶	RERUN Quick Test.
DA2 CHECK FOR V REF AT THROTTLE POSITION SENSOR		
• Refer to illustration Q. • Key Off, wait 10 seconds. • DVOM on 20V scale. • Disconnect TP sensor. • Key On, Engine Off. • Measure voltage at the TP vehicle harness connector between VREF and signal return.	Less than 4.0V or greater than 6.0V ▶	GO to Pinpoint Test Step **C1**.
	4.0V to 6.0V ▶	RECONNECT TP sensor, GO to **DA3**.
DA3 VAT SENSOR CHECK		
NOTE: Ambient temperature must be greater than 50°F for this test. • Key Off, wait 10 seconds. • Harness disconnected from the vane meter. • DVOM on 200,000 ohm scale. • Measure resistance at the VAT sensor between VAT signal and Signal Return. • Is reading from 125 ohms (240°F) to 3700 ohms (50°F)?	Yes ▶	REPLACE processor. RECONNECT harness to vane meter. RERUN Quick Test.
	No ▶	REPLACE vane meter. RERUN Quick Test.

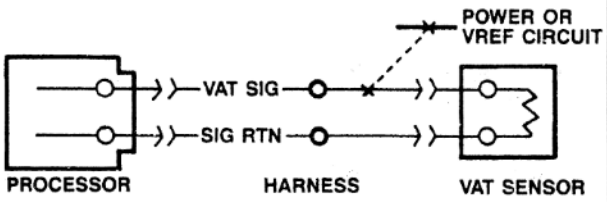
Vane Air Temperature Sensor (VAT) | Pinpoint Test | DA

TEST STEP	RESULT ▶	ACTION TO TAKE
DA10 SERVICE CODE 54: INDUCE OPPOSITE CODE		
• Key Off, wait 10 seconds. • Disconnect vehicle harness from vane meter. Inspect for damaged pins, corrosion, loose wires, etc. Service as necessary. • Insert a jumper wire (paper clip) at the vane meter vehicle harness connector between VAT Signal and Signal Return. • Run Key On, Engine Off Quick Test. • Is Code 64 present?	Yes ▶	REPLACE vane meter. REMOVE jumper wire. CONNECT harness to vane meter. RERUN Quick Test.
	No ▶	REMOVE jumper wire. GO to **DA11**.
DA11 CHECK CONTINUITY OF VAT SIGNAL AND SIGNAL RETURN		
• Key Off, wait 10 seconds. • Harness disconnected from vane meter, jumper wire removed. • Disconnect processor 60 pin connector. Inspect for damaged pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout box leaving processor disconnected. • DVOM on 200 ohm scale. • Measure resistance between VAT signal at the vane meter vehicle harness connector, and test Pin 25 at the Breakout box. • Measure resistance between signal return at the vane meter vehicle harness connector, and test Pin 46 at the Breakout box.	Both readings are less than 5 ohms ▶	REPLACE processor. REMOVE Breakout box. RECONNECT harness to vane meter and processor. RERUN Quick Test.
	Either reading is 5 ohms or greater ▶	CORRECT open circuit. REMOVE Breakout box. RECONNECT harness to vane meter and processor. RERUN Quick Test.

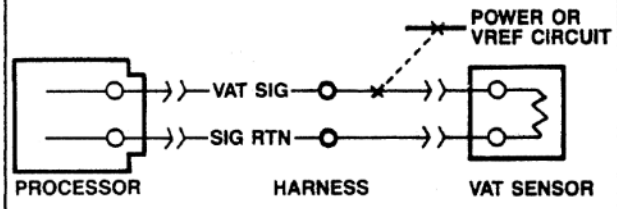
Vane Air Temperature Sensor (VAT) | Pinpoint Test | DA

TEST STEP	RESULT ▶	ACTION TO TAKE
DA20 SERVICE CODE 64: INDUCE OPPOSITE CODE • Key off, wait 10 seconds. • Disconnect vehicle harness from vane meter. Inspect for damaged pins, corrosion, loose wires, etc. Service as necessary. • Run Key On, Engine Off Quick Test. • Is code 54 present?	Yes ▶ No ▶	REPLACE vane meter. RECONNECT harness to vane meter. RERUN Quick Test. GO to **DA21**.
DA21 CHECK FOR V REF AT THROTTLE POSITION SENSOR • Refer to illustration Q. • Key Off, wait 10 seconds. • DVOM on 20V scale. • Disconnect TP sensor. • Key On, Engine Off. • Measure voltage at the TP vehicle harness connector between VREF and signal return.	Less than 4.0V or greater than 6.0V ▶ 4.0V to 6.0V ▶	GO to Pinpoint Test Step **C1**. RECONNECT TP sensor, GO to **DA22**.
DA22 CHECK VAT SIGNAL FOR SHORTS • Key Off, wait 10 seconds. • Harness disconnected from vane meter. • Disconnect processor 60 pin connector. Inspect for damaged pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout box leaving processor disconnected. • DVOM on 200,000 ohm scale. • Measure resistance between Test Pin 25 and Test Pins 40, 46 and 60 at the Breakout box.	Any reading less than 10,000 ohms ▶ All readings are 10,000 ohms or greater ▶	CORRECT circuit shorts. REMOVE Breakout box. RECONNECT processor and vane meter. RERUN Quick Test. REPLACE processor. REMOVE Breakout box. RECONNECT processor. RERUN Quick Test.

Vane Air Temperature Sensor (VAT) | Pinpoint Test | DA

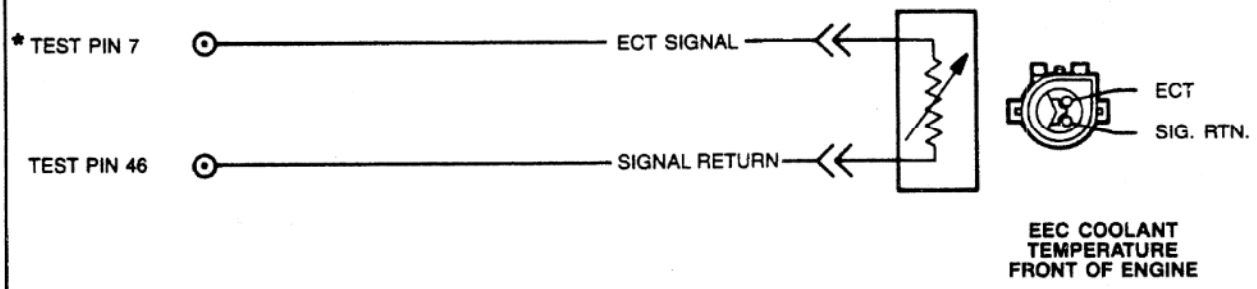
TEST STEP	RESULT ▶	ACTION TO TAKE
DA90 SERVICE CODE 54: CONTINUOUS TEST: CHECK VAT SENSOR		
• Using continuous monitor mode, observe VOM or STAR LED for indication of a fault while performing the following: • Lightly tap on VAT sensor (simulate road shock). • Wiggle VAT connector. • Is a fault indicated?  	Yes ▶ No ▶	DISCONNECT and INSPECT connectors. If connector and terminals are good, REPLACE VAT sensor. RERUN Quick Test. GO to **DA91**.
DA91 CHECK EEC-IV HARNESS		
• Observe VOM or STAR LED for a fault indication while performing the following: • Referring to the illustration in Step DA90, grasp the harness closest to the sensor connector. Wiggle, shake or bend a small section of the EEC-IV system harness while working your way to the dash panel. Also wiggle, shake or bend the EEC-IV harness from the dash panel to the processor. • Is fault indicated?	Yes ▶ No ▶	ISOLATE fault and make necessary repairs. RERUN Quick Test. GO to **DA92**.
DA92 CHECK PROCESSOR AND HARNESS CONNECTORS		
• Key Off, wait 10 seconds. • Disconnect processor 60 pin connector. • Inspect both connectors and connector terminals for obvious damage or faults. • Connectors and terminals are OK.	No ▶ Yes ▶	SERVICE as necessary. RERUN Quick Test. Unable to duplicate fault at this time. Continuous code 54 testing complete.

Vane Air Temperature Sensor (VAT) | Pinpoint Test | DA

TEST STEP	RESULT ▶	ACTION TO TAKE
DA93 SERVICE CODE 64: CONTINUOUS TEST: CHECK VAT SENSOR		
• Using continuous monitor mode, observe VOM or STAR LED for indication of a fault while performing the following: • Lightly tap on VAT sensor (simulate road shock). • Wiggle VAT connector. • Is fault indicated? 	Yes ▶ No ▶	DISCONNECT and INSPECT connectors. If connector and terminals are good, REPLACE VAT sensor. RERUN Quick Test. GO to **DA94**.
DA94 CHECK EEC-IV HARNESS		
• Observe VOM or STAR LED for a fault indication while performing the following: • Referring to the illustration in Step DA93, grasp the harness closest to the sensor connector. Wiggle, shake or bend a small section of the EEC-IV system harness while working your way to the dash panel. Also wiggle, shake or bend the EEC-IV harness from the dash panel to the processor. • Is fault indicated?	Yes ▶ No ▶	ISOLATE fault and make necessary service. RERUN Quick Test. GO to **DA95**.
DA95 CHECK PROCESSOR AND HARNESS CONNECTORS		
• Key Off, wait 10 seconds. • Disconnect processor 60 pin connector. • Inspect both connectors and connector terminals for obvious damage or faults. • Connectors and terminals are OK.	No ▶ Yes ▶	SERVICE as necessary. RERUN Quick Test. Unable to duplicate fault at this time. Continuous code 64 testing complete.

Engine Coolant Temperature Sensor (ECT)	Pinpoint Test	DE

DE



EEC COOLANT TEMPERATURE FRONT OF ENGINE

NOTE: TO PASS THIS TEST, ENGINE COOLANT TEMPERATURE MUST BE:
KEY ON, ENGINE OFF (50°F TO 240°F)
ENGINE RUNNING (180°F TO 240°F)

TYPICAL RESISTANCE BETWEEN TEST PINS 7 & 46	58,750Ω	40,500Ω	3600Ω	1840Ω
AT TEMPERATURE	50°F	65°F	180°F	220°F

***TEST PIN LOCATED ON BREAKOUT BOX.**
ALL CONNECTIONS VIEWED INTO MATING SURFACE.

STOP-WARNING

You should enter this Pinpont Test only when a service code 21, 51 or 61 is received in Quick Test Step 3.0, 5.0 or 6.0.

To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

- Coolant level.
- Oil level.
- Blocked or obstructed air flow.
- Engine not at normal operating temperature.
- Electro drive cooling fan.

This pinpoint test is intended to diagnose only the following:

- ECT sensor.
- Harness sensor circuits: ECT and Signal Return.
- Processor assembly.

Engine Coolant Temperature Sensor (ECT) | Pinpoint Test | DE

TEST STEP	RESULT ▶	ACTION TO TAKE
DE1 SERVICE CODE 21: CHECK ENGINE OPERATING TEMPERATURE		
• Run engine for 2 minutes at 2,000 rpm. • Check that upper radiator hose is hot and pressurized. • Rerun Quick Test.	Vehicle stalls ▶	Do not service code 21 at this time. REFER to diagnosis by symptoms.
	Code 21 present ▶	GO to **DE2**.
	Code 21 not present ▶	SERVICE other codes as necessary.
DE2 CHECK FOR V REF AT THROTTLE POSITION SENSOR		
• Refer to illustration Q. • Key Off, wait 10 seconds. • DVOM on 20V scale. • Disconnect TP sensor. • Key On, Engine Off. • Measure voltage at the TP vehicle harness connector between VREF and signal return.	Less than 4.0V or greater than 6.0V ▶	GO to Pinpoint Test Step **C1**.
	4.0V to 6.0V ▶	RECONNECT TP sensor, GO to **DE3**.
DE3 ECT SENSOR CHECK		
NOTE: Engine may have cooled down. Always warm engine before taking ECT resistance measurement. • Key Off, wait 10 seconds. • Harness disconnected from ECT sensor. • DVOM on 200,000 ohm scale. • Measure resistance of the ECT sensor. • Is the resistance reading: — 1300 ohms (240°F) to 7700 ohms (140°F) for engine off? — 1550 ohms (230°F) to 4550 ohms (180°F) for engine running?	Yes ▶	REPLACE processor. RECONNECT harness to ECT sensor. RERUN Quick Test.
	No ▶	REPLACE ECT sensor. RECONNECT harness to ECT sensor. RERUN Quick Test.

Engine Coolant Temperature Sensor (ECT) | Pinpoint Test | DE

TEST STEP		RESULT	ACTION TO TAKE
DE10	SERVICE CODE 51: INDUCE OPPOSITE CODE		
• Key Off, wait 10 seconds. • Disconnect vehicle harness from ECT sensor. Inspect for damaged pins, corrosion, loose wires, etc. Service as necessary. • Insert a jumper wire at the ECT sensor vehicle harness connector between ECT Signal and Signal Return. • Run Key On, Engine Off Quick Test. • Is code 61 present?		Yes ▶ No ▶	REPLACE ECT sensor. REMOVE jumper wire. RECONNECT ECT sensor. RERUN Quick Test. GO to **DE11**.
DE11	CHECK CONTINUITY OF ECT SIGNAL AND SIGNAL RETURN		
• Key Off, wait 10 seconds. • Harness disconnected from ECT sensor, jumper wire removed. • Disconnect processor 60 pin connector. Inspect for damaged pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout box to harness leaving processor disconnected. • DVOM on 200 ohm scale. • Measure resistance between ECT signal at the ECT vehicle harness connector and test Pin 7 at the Breakout box. • Measure resistance between Signal Return at the ECT sensor vehicle harness connector, and test Pin 46 at the Breakout box.		Both readings are less than 5 ohms. ▶ Either reading is 5 ohms or greater ▶	REPLACE processor. REMOVE Breakout box. RECONNECT processor and ECT sensor. RERUN Quick Test. SERVICE open circuit(s). REMOVE Breakout box. RECONNECT processor and ECT sensor. RERUN Quick Test.

Engine Coolant Temperature Sensor (ECT) | Pinpoint Test | DE

TEST STEP	RESULT ▶	ACTION TO TAKE
DE20 SERVICE CODE 61: INDUCE OPPOSITE CODE		
• Key Off, wait 10 seconds. • Disconnect vehicle harness from ECT sensor. Inspect for damaged pins, corrosion, loose wires, etc. Service as necessary. • Run Key On, Engine Off Quick Test. • Is code 51 present?	Yes ▶	REPLACE ECT sensor. RECONNECT ECT sensor. RERUN Quick Test.
	No ▶	GO to **DE21**.
DE21 CHECK FOR V REF AT THROTTLE POSITION SENSOR		
• Key Off, wait 10 seconds. • DVOM on 20V scale. • Disconnect TP sensor. • Key On, Engine Off. • Measure voltage at the TP vehicle harness connector between VREF and signal return.	Less than 4.0V or greater than 6.0V ▶	GO to Pinpoint Test Step **C1**.
	4.0V to 6.0V ▶	RECONNECT TP sensor, GO to **DE22**.
DE22 CHECK ECT SIGNAL FOR SHORT		
• Key Off, wait 10 seconds. • Harness disconnected from ECT sensor. • Disconnect processor 60 pin connector. Inspect for damaged pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout box, leave processor disconnected. • DVOM on 200,000 ohm scale. • Measure resistance between test Pin 7 and test Pins 40, 46 and 60 at the Breakout box.	Either reading is less than 10,000 ohms ▶	SERVICE circuit shorts. REMOVE Breakout box. RECONNECT processor and ECT sensor. RERUN Quick Test.
	Both readings are 10,000 ohms or greater ▶	REPLACE processor. REMOVE Breakout box. RECONNECT processor and ECT harness. RERUN Quick Test.

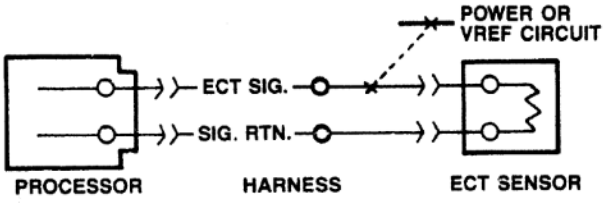
Engine Coolant Temperature Sensor (ECT)

Pinpoint Test

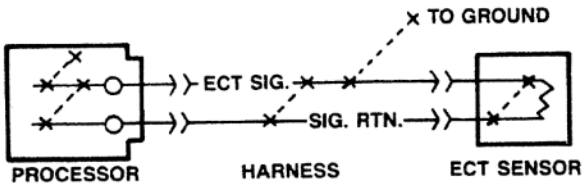
DE

TEST STEP		RESULT ▶	ACTION TO TAKE
DE90	SERVICE CODE 21: CONTINUOUS TEST: TEST DRIVE VEHICLE		
• Key Off and wait 10 seconds. • Disconnect all Self-Test equipment and prepare vehicle for test drive. • Drive vehicle. Try to simulate different drive modes or mode in which drive complaint is noticed. Attempt to maintain drive complaint mode for one minute or more, if possible. • Upon completion of drive evaluation, repeat Key On, Engine Off Self-Test. • Is code 21 present in the continuous test results?		Yes ▶	VERIFY thermostat operating properly. If OK, REPLACE ECT sensor. RERUN Quick Test.
		No ▶	Unable to duplicate fault. Code 21 testing complete.

Engine Coolant Temperature (ECT) | Pinpoint Test | DE

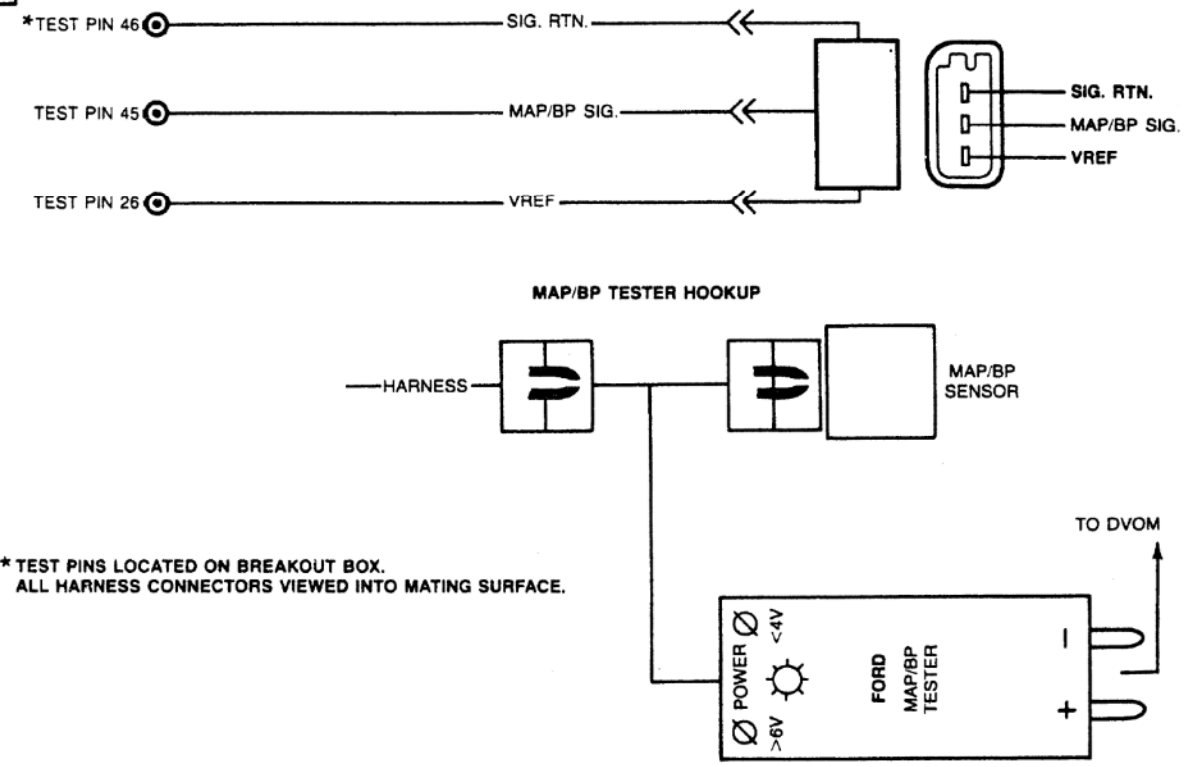
TEST STEP	RESULT ▶	ACTION TO TAKE
DE91 SERVICE CODE 51: CONTINUOUS TEST: CHECK ECT SENSOR		
• Using continuous monitor mode, observe VOM or STAR LED for indication of a fault while performing the following: • Lightly tap on ECT sensor (simulate road shock). • Wiggle ECT connector. • Is a fault indicated?  	Yes ▶ No ▶	DISCONNECT and INSPECT connectors. If connector and terminals are good, REPLACE ECT sensor. RERUN Quick Test. GO to **DE92**.
DE92 CHECK EEC-IV HARNESS		
• Observe VOM or STAR LED for a fault indication while performing the following: • Referring to the illustration in Step DE91, grasp the harness closest to the sensor connector. Wiggle, shake or bend a small section of the EEC-IV system harness while working your way to the dash panel. Also wiggle, shake or bend the EEC-IV harness from the dash panel to the processor. • Is fault indicated?	Yes ▶ No ▶	ISOLATE fault and make necessary repairs. RERUN Quick Test. GO to **DE93**.
DE93 CHECK PROCESSOR AND HARNESS CONNECTORS		
• Key Off, wait 10 seconds. • Disconnect processor 60 pin connector. • Inspect both connectors and connector terminals for obvious damage or faults. • Connectors and terminals are OK.	No ▶ Yes ▶	SERVICE as necessary. RERUN Quick Test. Unable to duplicate fault at this time. Continuous code 51 testing complete.

Engine Coolant Temperature (ECT) | Pinpoint Test | DE

TEST STEP	RESULT ▶	ACTION TO TAKE
DE94 SERVICE CODE 61: CONTINUOUS TEST: CHECK ECT SENSOR		
• Using continuous monitor mode, observe VOM or STAR LED for indication of a fault while performing the following: • Lightly tap on ECT sensor (simulate road shock). • Wiggle ECT connector. Voltage greater than 5 volts or STAR LED Off. • Is fault indicated? 	Yes ▶ No ▶	DISCONNECT and INSPECT connectors. If connector and terminals are good, REPLACE ECT sensor. RERUN Quick Test. GO to **DE95**.
DE95 CHECK EEC-IV HARNESS		
• Observe VOM or STAR LED for a fault indication while performing the following: • Referring to the illustration in Step DE94, grasp the harness closest to the sensor connector. Wiggle, shake or bend a small section of the EEC-IV system harness while working your way to the dash panel. Also wiggle, shake or bend the EEC-IV harness from the dash panel to the processor. • Is fault indicated?	Yes ▶ No ▶	ISOLATE fault and make necessary repairs. RERUN Quick Test. GO to **DE96**.
DE96 CHECK PROCESSOR AND HARNESS CONNECTORS		
• Key Off, wait 10 seconds. • Disconnect processor 60 pin connector. • Inspect both connectors and connector terminals for obvious damage or faults. • Connectors and terminals are OK.	No ▶ Yes ▶	SERVICE as necessary. RERUN Quick Test. Unable to duplicate fault at this time. Continuous code 61 testing complete.

Barometric Pressure (BP) Sensor	Pinpoint Test	DF

DF



STOP-WARNING

You should enter this Pinpoint Test only when a Service Code 22 is received in Quick Test Step 3.0, 5.0 or 6.0 or when directed here from Diagnostics by Symptom in the Engine Supplement Section.

To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

- Unusually high/low atmospheric barometer reading.

This Pinpoint Test is intended to diagnose only the following:

- BP sensor.
- Harness circuits: VREF, BP Signal, and Signal Return.
- Processor assembly.

Manifold Absolute Pressure (MAP)/ Barometric Pressure (BP) Sensor	Pinpoint Test	DF

TEST STEP	RESULT ▶	ACTION TO TAKE
FAULT CODE 22, ENGINE OFF		
DF1 CONNECTING MAP/BP TESTER		
• Key Off. • Disconnect the MAP/BP sensor from the vehicle harness. • Connect the MAP/BP tester between the vehicle harness and the MAP/BP sensor. • Insert tester banana plugs into DVOM. • Set DVOM to 20V scale. • Refer to illustration DF.	Tester properly hooked up ▶	GO to **DF2**.
DF2 POWER TO MAP/BP SENSOR TEST		
• MAP/BP tester connected. • Key On.	(ONLY) Green light, VREF is OK ▶	GO to **DF4**.
	"Less than 4V" light (RED) or no lights, VREF is too low ▶ OR "Greater than 6V" light (Red), VREF is too high	GO to **DF3**.
DF3 VREF ISOLATION		
• MAP/BP tester connected. • Key On. • Disconnect MAP/BP • Repeat Test Step DF2.	(ONLY) Green light, VREF is OK ▶	REPLACE MAP/BP sensor. RERUN Quick Test.
	"Less than 4V" light (RED) or no lights, VREF is too low ▶ OR "Greater than 6V" light (Red), VREF is too high	REMOVE MAP/BP tester. GO to Pinpoint Test Step **C1**.

Manifold Absolute Pressure (MAP)/ Barometric Pressure (BP) Sensor	Pinpoint Test	DF

TEST STEP	RESULT ▶	ACTION TO TAKE
DF4 MAP/BP TESTER OUTPUT READING • MAP tester connected, refer to Note. • Key On. • Approximate Altitude (Ft.) / Voltage Output (+/−.04 Volts): 0 — 1.59 1000 — 1.56 2000 — 1.53 3000 — 1.50 4000 — 1.47 5000 — 1.44 6000 — 1.41 7000 — 1.39 **NOTE: Measure several known good MAP sensors on available vehicles. The measured voltage will be typical for your location on the day of testing.** • Is reading in range for your altitude?	Yes ▶ No (Sensor output is out-of-range) ▶	GO to DF5. GO to DF6.
DF5 CHECK CONTINUITY OF MAP/BP SIGNAL • Key Off, wait 10 seconds. • Harness disconnected from MAP/BP sensor. • Disconnect processor 60 Pin connector. Inspect for damaged pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout box. Leave processor disconnected. • DVOM on 200 ohm scale. • Measure resistance between MAP/BP signal at the MAP/BP sensor vehicle harness connector and test Pin 45 at the Breakout box.	Reading less than 5 ohms ▶ Reading is 5 ohms or greater ▶	REPLACE processor. CONNECT harness and MAP/BP sensor. RERUN Quick Test. SERVICE circuit opens. REMOVE Breakout box. RECONNECT processor and MAP/BP sensor. RERUN Quick Test.
DF6 CHECK MAP/BP SIGNAL FOR SHORTS TO VREF; SIGNAL RETURN AND GROUND • Key Off, wait 10 seconds. • Disconnect processor 60 Pin connector and inspect for damaged pins, corrosion, loose wires. Service as necessary. • Install Breakout box, leave processor disconnected. • Harness disconnected from MAP/BP sensor. • DVOM on 200,000 ohm scale. • Measure resistance between test Pin 45 and test Pins 26, 46, 40 and 60 at the Breakout box.	Any reading less than 10,000 ohms ▶ All readings are 10,000 ohms or greater ▶	SERVICE circuit shorts. REMOVE Breakout box. RECONNECT processor and MAP/BP Sensor. RERUN Quick Test. REPLACE MAP/BP sensor. REMOVE Breakout box. RECONNECT electrical connections. RERUN Quick Test.

Manifold Absolute Pressure (MAP)/ Barometric Pressure (BP) Sensor	Pinpoint Test	DF

TEST STEP	RESULT ▶	ACTION TO TAKE
CODE 22 ENGINE RUNNING		
DF7 CHECK MAP SENSOR		
• Key Off, wait 10 seconds. • Disconnect vacuum line from MAP sensor. • Install vacuum pump to MAP sensor. • Apply 18 in. Hg vacuum to MAP sensor. • Does MAP sensor hold vacuum?	Yes ▶	RELEASE vacuum. GO to **DF8**.
	No ▶	REPLACE MAP sensor. CONNECT vacuum line to MAP sensor. RERUN Quick Test.
DF8 ATTEMPT TO ELIMINATE CODE 22 (ENGINE RUNNING)		
• Key Off, wait 10 seconds. • Plug MAP vacuum supply hose. • Start engine and maintain 1500 ± 100 engine rpm. • Slowly apply 15 in. Hg vacuum to MAP sensor. • While maintaining rpm, perform Engine Running Quick Test. • Is code 22 still present? **NOTE: Disregard any other codes at this time.**	Yes ▶	REPLACE MAP sensor. CONNECT vacuum line to MAP sensor. RERUN Quick Test.
	No ▶	INSPECT vacuum supply hose to MAP sensor. SERVICE as necessary. If OK, SERVICE other engine running codes. If none, GO to Diagnostic Routines, Section 2 for a low vacuum problem.
FAULT CODE 72		
DF10 CHECK THAT VACUUM TO MAP SENSOR DECREASES DURING DYNAMIC RESPONSE		
• Key Off, wait 10 seconds. • Tee a vacuum gauge in the intake manifold vacuum line at the MAP sensor. • Perform Engine Running Quick Test while observing vacuum. • Record engine service codes. • Did vacuum decrease by more than 30 kPa (10 in. Hg) during dynamic response test? • Is code 72 present?	Vacuum decrease is 30 kPa (10 in. Hg) or greater and code 72 is not present ▶	DISCONNECT vacuum equipment and SERVICE other codes as necessary.
	Vacuum decrease is 30 kPa (10 in. Hg) or greater and code 72 is present ▶	REPLACE MAP sensor and RERUN Quick Test.
	Vacuum decrease is less than 30 kPa (10 in. Hg) ▶	GO to **DF11**.

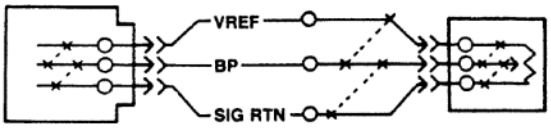
Manifold Absolute Pressure (MAP)/ Barometric Pressure (BP) Sensor — Pinpoint Test — DF

TEST STEP	RESULT ▶	ACTION TO TAKE
DF11 CHECK VACUUM LINES • Check vacuum line for proper routing. Refer to VECI decal. Check MAP sensor vacuum line for kinks or blockage. • Vacuum lines are OK.	Yes ▶	EEC-IV system OK. REFER to Shop Manual, Group 21 for probable subjects affecting engine vacuum.
	No ▶	SERVICE as necessary and REPEAT **DF10**.
DF20 CONNECTING MAP/BP TESTER • Key Off. • Disconnect the MAP/BP sensor from the vehicle harness. • Connect the MAP/BP Tester between the vehicle harness and the MAP/BP sensor. • Plug tester banana plugs into DVOM. • Set DVOM to 20V scale. • Refer to illustration DF.	Tester properly hooked up ▶	GO to **DF21**.
DF21 MAP/BP TESTER OUTPUT READING • MAP Tester connected, refer to Note. • Key On. • Approximate Altitude (Ft.) / Voltage Output (+/−.04 Volts) 0 — 1.59 1000 — 1.56 2000 — 1.53 3000 — 1.50 4000 — 1.47 5000 — 1.44 6000 — 1.41 7000 — 1.39 **NOTE: Measure several known good MAP sensors on available vehicles. The measured voltage will be typical for your location on the day of testing.** • Is reading in range for your altitude?	Yes ▶	For 1.9L EFI and 2.3L EFI TC engines GO to Diagnostic by Symptom in the Engine Supplement Section. For all others. GO to **DF22**.
	No (Sensor output is out-of-range) ▶	REPLACE MAP/BP sensor.

Manifold Absolute Pressure (MAP)/ Barometric Pressure (BP) Sensor	Pinpoint Test	DF

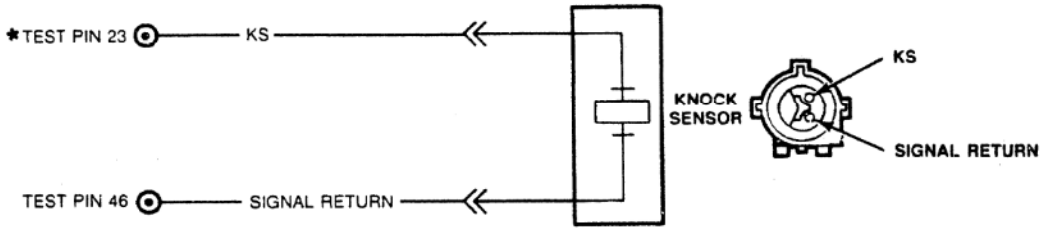
TEST STEP	RESULT ▶	ACTION TO TAKE
DF22 VACUUM LINE CHECK		
• Check MAP sensor vacuum line for holes, disconnections, kinks or blockage. • Are vacuum lines OK?	Yes ▶	GO to Diagnostics by Symptom in the Engine Supplement Section.
	No ▶	SERVICE vacuum lines to MAP sensor. RERUN Quick Test.

Manifold Absolute Pressure (MAP)/ Barometric Pressure (BP) Sensor	Pinpoint Test	DF

TEST STEP	RESULT ▶	ACTION TO TAKE
DF90 SERVICE CODE 22: CONTINUOUS TEST: EXERCISE MAP SENSOR		
• Using continuous monitor mode, observe VOM or STAR LED for indication of a fault while performing the following: • Connect a vacuum pump to the MAP sensor. • Slowly apply 84 kPa (25 in. Hg.) vacuum to the sensor. • Slowly bleed vacuum off the MAP sensor. • Lightly tap on MAP sensor (simulate road shock). • Wiggle MAP connector. • Is fault indicated? 	Yes ▶ No ▶	DISCONNECT and INSPECT connectors. If connector and terminals are good, REPLACE sensor. RERUN Quick Test. GO to **DF91**.
DF91 CHECK EEC-IV HARNESS		
• Observe VOM or STAR LED for a fault indication while performing the following: • Referring to the illustration in Step DF90, grasp the harness closest to the sensor connector. Wiggle, shake or bend a small section of the EEC-IV system harness while working your way to the dash panel. Also wiggle, shake or bend the EEC-IV harness from the dash panel to the processor. • Is a fault indicated?	Yes ▶ No ▶	ISOLATE fault and SERVICE as necessary. RERUN Quick Test. GO to **DF92**.
DF92 CHECK PROCESSOR AND HARNESS CONNECTORS		
• Key Off, wait 10 seconds. • Disconnect processor 60 Pin connector. • Inspect both connectors and connector terminals for obvious damage or faults. • Are connectors and terminals OK?	No ▶ Yes ▶	SERVICE as necessary. RERUN Quick Test. Unable to duplicate fault at this time. Continuous code 22 testing complete.

Knock Sensor	Pinpoint Test	DG

DG



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

STOP-WARNING

You should enter this Pinpoint Test only when a service code 25 is received in Quick Test Step 5.0 or you are directed here from Diagnostics by Symptom in the Engine Supplement Section.

To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

- Fuel (quality).
- Basic engine.
- Spark timing.

This Pinpoint Test is intended to diagnose only the following:

- Knock sensor.
- Harness circuits: KS and Signal Return.
- Processor assembly.

Knock Sensor | Pinpoint Test | DG

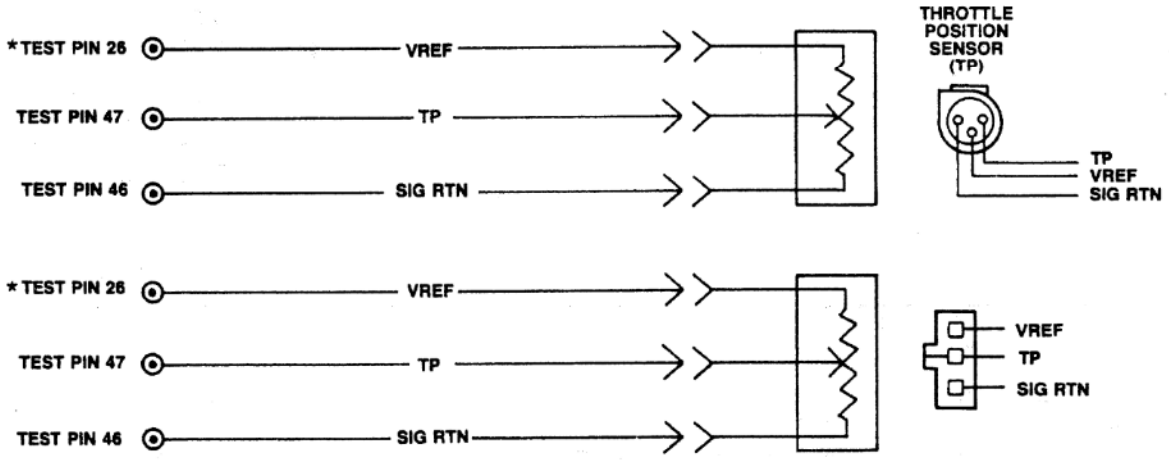
TEST STEP	RESULT ▶	ACTION TO TAKE
DG1 SERVICE CODE 25: GENERATE KNOCK MANUALLY		
NOTE: With knock conditions sensitive to fuel, altitude and weather, perform Step DG1 before servicing any components. • Vehicle prepared to run (Engine Running Self-Test). • Equipment needed: 4 oz. hammer. • Prepare to rap/tap on intake manifold, directly above the knock sensor, when the Dynamic Response Signal is given. **NOTE: There is no need to actually depress throttle at this point.** • Perform Engine Running Self-Test. • Rap moderately on exhaust manifold when meter indicates Dynamic Response Test is ready. • 15 seconds later a code will be generated. • Check for code 25. **NOTE: Ignore all other codes at this point.**	No ▶ Yes ▶ **NOTE: Service code 25 may be received whenever the engine is not tapped**	Knock system OK. REPEAT Engine Running Self-Test and SERVICE any other codes from that test. GO to **DG2**.
DG2 TEST KNOCK CIRCUIT FOR VOLTAGE		
• Key Off, wait 10 seconds. • Disconnect knock sensor connector and inspect. • Set DVOM on 20V scale. • Key On, Engine Off. • Measure voltage at the vehicle harness connector between KS and signal return.	Voltage is between 1 and 4V ▶ Voltage is less than 1V ▶ Voltage is greater than 4V ▶	GO to **DG6**. GO to **DG3**. GO to **DG5**.
DG3 CHECK CONTINUITY OF KS AND SIGNAL RETURN CIRCUITS		
• Key Off, wait 10 seconds. • Disconnect processor 60 Pin connector and inspect for damaged pins, corrosion, loose wires. Service as necessary. • Connect Breakout box to harness. Leave processor disconnected. • Knock sensor disconnected. • DVOM on 200 ohm scale. • Measure resistance between Signal Return at the vehicle harness and test Pin 46 at the Breakout box and between KS at the vehicle harness and test Pin 23 at the Breakout box.	Both resistances less than 5 ohms ▶ Either resistance 5 ohms or greater ▶	GO to **DG4**. SERVICE open circuit. RERUN Quick Test.

Knock Sensor | Pinpoint Test | DG

TEST STEP	RESULT ▶	ACTION TO TAKE
DG4 CHECK KS CIRCUIT FOR SHORT TO GROUND • Key Off, wait 10 seconds. • Breakout box installed. • Processor disconnected. • Knock sensor disconnected. • DVOM on 200,000 ohm scale. • Measure resistance between KS at the vehicle harness and test Pins 40, 46 and 60 at the Breakout box.	All resistances 10,000 ohms or greater ▶	GO to **DG6**.
	Any resistance less than 10,000 ohms ▶	SERVICE harness short. RERUN Quick Test.
DG5 CHECK KS CIRCUIT FOR SHORT TO VOLTAGE • Key Off, wait 10 seconds. • Disconnect processor 60 Pin connector and inspect for damaged pins, corrosion, loose wires. Service as necessary. • Connect Breakout box to harness. Leave processor disconnected. • Knock sensor disconnected. • Key On, Engine Off. • DVOM on 20V scale. • Measure voltage between test Pin 23 and test Pin 40 at the Breakout box.	0.5V or greater ▶	SERVICE harness short to power. RERUN Quick Test.
	Less than 0.5V ▶	GO to **DG6**.
DG6 TEST PROCESSOR WITH SUBSTITUTE KNOCK SENSOR • Key Off, wait 10 seconds. • Remove Breakout box and reconnect processor. • Equipment Required: — Equivalent knock sensor (same part number). — 4 oz. hammer. • Plug substitute sensor in harness (do not install). • Perform Engine Running Self-Test. • Lightly tap knock sensor when Dynamic Test Ready Signal is given. • 15 seconds later, a code will be generated. • Check for code 25. **NOTE: Ignore all other codes at this time.**	No ▶	INSTALL new knock sensor. RERUN Quick Test.
	Yes ▶	REPLACE processor and REMOVE substitute sensor. RERUN Quick Test with original sensor.

Throttle Position Sensor (TPS) | Pinpoint Test | DH

DH



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

STOP-WARNING

You should enter this Pinpoint Test only when a Service Code 23, 53, 63 or 73 is received in Quick Test Step 3.0, 5.0 or 6.0.

To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

- Idle speeds/throttle stop adjustment.
- Binding throttle shaft/linkage or speed control linkage.
- Choke/high cam system, if equipped.

This Pinpoint Test is intended to diagnose only the following:

- TP sensor.
- Sensor harness circuits: VREF, TP Signal, and Signal Return.
- Processor assembly.

Throttle Position Sensor (TPS) | Pinpoint Test | DH

TEST STEP		RESULT ▶	ACTION TO TAKE
DH1	SERVICE CODE 23: THE FOLLOWING CHECK MUST BE MADE BEFORE SERVICING THIS CODE		
• Check for code 68; Key On, Engine Off or codes 58, 31 or 41 Engine Running.		Code(s) present ▶	DISREGARD Code 23 at this time and RETURN to Quick Test Step 3.0B for code 68 or Step 5.0B for codes 31, 41 or 58. PROCEED as directed.
		No codes present ▶	GO to **DH2**.
DH2	CHECK FOR STUCK THROTTLE PLATE		
• Visually inspect carburetor/throttle body and throttle linkage for binding or sticking. • Verify the throttle linkage is at mechanical/ closed throttle. Check for: binding throttle linkage, speed control linkage, vacuum line/ electrical harness interference, etc.		Throttle not stuck ▶	GO to **DH3**.
		Throttle stuck ▶	CORRECT faults. RERUN Quick Test.
DH3	GENERATE CODE 63		
• Refer to illustration DH. • Key Off, wait 10 seconds. • Disconnect TP sensor vehicle harness connector at the throttle body. Inspect for damaged pins, corrosion, loose wires, etc. Service as necessary. • Perform Key On, Engine Off self-test and record codes. **NOTE: Ignore all other codes at this time.**		Code 63 present ▶	GO to **DH4**.
		Code 63 not present ▶	GO to **DH5**.
DH4	CHECK VOLTAGE VREF TO SIGNAL RETURN		
• Refer to illustration DH. • Key Off, wait 10 seconds. • Disconnect TP vehicle harness connector at throttle body. Inspect for damaged pins, corrosion, and pins pushed out. Service as necessary. • DVOM on 20V scale. • Key On, Engine Off. • Measure voltage at the TP vehicle harness connector between VREF and Signal Return.		Voltage reading between 4V and 6V ▶	REPLACE TP sensor. REFER to Section 3 before replacement for adjustment procedures for EFI applications. RERUN Quick Test.
		Voltage reading less than 4V or greater than 6V ▶	GO to Pinpoint Test Step **C1**.

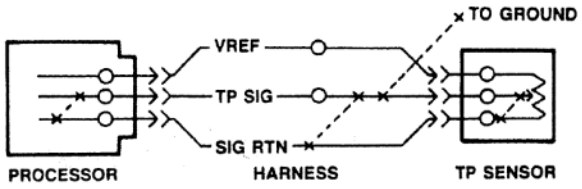
Throttle Position Sensor (TPS) | Pinpoint Test | DH

TEST STEP	RESULT ▶	ACTION TO TAKE
DH5 CHECK TP SIGNAL FOR SHORT TO POWER		
• Key Off, wait 10 seconds, TP harness disconnected. • DVOM on 200,000 ohm scale. • Disconnect processor 60 Pin connector and inspect for damaged pins, corrosion, loose wires. Service as necessary. • Install Breakout box, leave processor disconnected. • Measure resistance between test Pin 47 and test Pins 26 and 57 at the Breakout box.	Either resistance is less than 10,000 ohms ▶ Both resistances are 10,000 ohms or greater ▶	SERVICE harness short. RERUN Quick Test. REPLACE processor. RERUN Quick Test.
DH10 SERVICE CODE 63: GENERATE CODE 53		
• Key Off, wait 10 seconds, TP harness disconnected. • Jumper VREF to TP signal at TP vehicle harness connector. • Perform Key On, Engine Off self-test. **NOTE: If no codes are generated, immediately remove jumper and go directly to DH13.** • Check for Code 53 (Code 23) **NOTE: Ignore all other codes at this time.**	Code 53 present (Code 23 present) ▶ Code 53 not present (Code 23 not present) ▶	REPLACE TP sensor, REFER to Section 3 before replacement for adjustment procedures for EFI applications and RERUN Quick Test. GO to DH11.
DH11 SERVICE CODE 63: CHECK VOLTAGE VREF TO SIGNAL RETURN		
• Refer to illustration DH. • Key Off, wait 10 seconds. • Disconnect TP vehicle harness connector at throttle body. Inspect for damaged pins, corrosion, and pins pushed out. Service as necessary. • DVOM on 20V scale. • Key On, Engine Off. • Measure voltage at the TP vehicle harness connector between VREF and Signal Return.	Voltage reading between 4V and 6V ▶ Voltage reading less than 4V or greater than 6V ▶	GO to DH12. GO to Pinpoint Test Step C1

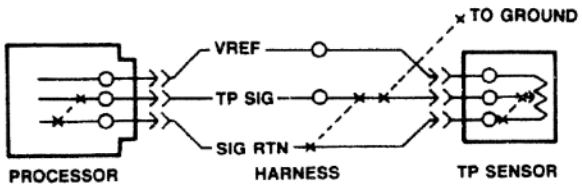
Throttle Position Sensor (TPS) | Pinpoint Test | DH

TEST STEP	RESULT ▶	ACTION TO TAKE
DH12 CHECK CONTINUITY OF TP CIRCUIT		
• Key Off, wait 10 seconds, TP harness disconnected. • DVOM on 200 ohm scale. • Disconnect processor 60 Pin connector and inspect for damaged pins, corrosion, loose wires. Service as necessary. • Connect Breakout box. Processor connected to Breakout box. • Measure resistance between TP Signal at the vehicle harness connector and test Pin 47 at the Breakout box.	Reading 5 ohms or greater ▶ Readings less than 5 ohms ▶	SERVICE faulty circuit. CONNECT throttle position sensor. REMOVE Breakout box and RERUN Quick Test. GO to **DH13**.
DH13 CHECK RESISTANCE OF TP CIRCUIT TO GROUND/SIGNAL RETURN		
• Key Off, wait 10 seconds, TP harness disconnected. • Disconnect processor 60 Pin connector and inspect for damaged pins, corrosion, loose wires. Service as necessary. • DVOM on 200,000 ohm scale. • Measure resistance between TP signal at TP vehicle harness connector and test Pin 46 at the Breakout box and between TP signal at TP vehicle harness connector and ground.	Either reading is less than 10,000 ohms ▶ Both readings are 10,000 ohms or greater ▶	SERVICE circuit short and RERUN Quick Test. REPLACE processor. CONNECT throttle position sensor. REMOVE Breakout box and RERUN Quick Test.
DH20 SERVICE CODE 73: TP SENSOR MOVES IN ENGINE RESPONSE TEST		
NOTE: Code 73 indicates the TP Sensor did not exceed 25 percent of its rotation in the Engine Response Check. • Key Off. • Install Breakout box. • DVOM on 20V scale. • Connect DVOM to test Pins 47 and 46 at the Breakout box. • Perform Engine Running Quick Test, Step 5.0. • Verify DVOM reading exceeds 3.5V during brief WOT at Engine Response Check.	Reading exceeds 3.5V during Engine Response Check ▶ Reading does not exceed 3.5V during Engine Response Check ▶	REPLACE processor. RERUN Quick Test. VERIFY TP Sensor is properly attached to throttle body. If OK, REPLACE TP Sensor. Refer to Section 3 before replacement for adjustment procedures for EFI applications. RERUN Quick Test.

Throttle Position Sensor (TPS) — Pinpoint Test — DH

TEST STEP	RESULT ▶	ACTION TO TAKE
DH90 CONTINUOUS TEST SERVICE CODE 53: EXERCISE TP SENSOR		
• Using continuous monitor mode, observe VOM or STAR LED for indication of a fault while performing the following: • Move throttle slowly to WOT position. • Release throttle slowly to closed position and lightly tap on TP sensor (simulate road shock). • Wiggle TP harness connector. • Is a fault indicated?  	Yes ▶ No ▶	GO to **DH91**. GO to **DH92**.
DH91 MEASURE THROTTLE POSITION SIGNAL VOLTAGE WHILE EXERCISING TP SENSOR		
• Key Off, wait 10 seconds. • Disconnect processor 60 Pin connector and inspect for damaged pins, corrosion, loose wires. Service as necessary. • Install Breakout box and reconnect processor. • VOM or STAR LED still connected to STO as in previous step. • Connect a DVOM from test Pin 47 to test Pin 46. • DVOM on 20V scale. • Key On, engine Off. • While observing DVOM, repeat Step DH90. • Does the fault occur below 4.25V?	Yes ▶ No ▶	DISCONNECT and INSPECT connectors. If connector and terminals are good, REPLACE TP sensor, REFER to Group 24 and RERUN Quick Test. Throttle position sensor overtravel may have caused the continuous code 53. Sensor service is not required. To verify harness integrity, GO to **DH92**.

Throttle Position Sensor (TPS) | Pinpoint Test | DH

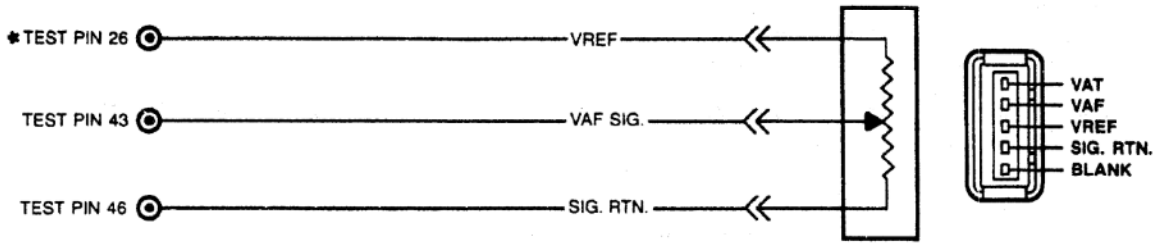
TEST STEP	RESULT ▶	ACTION TO TAKE
DH92 CHECK EEC-IV HARNESS • Observe VOM or STAR LED for a fault indication while performing the following: • Referring to the illustration in Step DH90, grasp the harness close to the sensor connector. Wiggle, shake or bend a small section of the EEC-IV system harness while working your way to the dash panel. Also wiggle, shake or bend the EEC-IV harness from the dash panel to the processor. • Is a fault indicated?	Yes ▶ No ▶	ISOLATE fault and make necessary repairs. REFER to appropriate figure. RERUN Quick Test. GO to **DH93**.
DH93 CHECK PROCESSOR AND HARNESS CONNECTORS • Key Off, wait 10 seconds. • Disconnect processor 60 Pin connector. • Inspect both connectors and connector terminals for obvious damage or faults. • Are connectors and terminals OK?	No ▶ Yes ▶	SERVICE as necessary. REPEAT Quick Test. Unable to duplicate fault at this time. Continuous code 53 testing complete.
DH94 CONTINUOUS TEST SERVICE CODE 63: EXERCISE TP SENSOR • Using continuous monitor mode, observe VOM or STAR LED for indication of a fault while performing the following: • Move throttle slowly to WOT position. • Release throttle slowly to closed condition. • Lightly tap on TP sensor (simulate road shock). • Wiggle TP harness connector. • Is a fault indicated?  	Yes ▶ No ▶	DISCONNECT and INSPECT connectors. If connector and terminals are good, REPLACE TP sensor, REFER to Group 24 and RERUN Quick Test. GO to **DH95**.

Throttle Position Sensor (TPS) | Pinpoint Test | DH

TEST STEP	RESULT ▶	ACTION TO TAKE
DH95 CHECK EEC-IV HARNESS		
• Observe VOM or STAR LED for a fault indication while performing the following: • Referring to the illustration in Step DH94 grasp the harness close to the sensor connector. Wiggle, shake or bend a small section of the EEC-IV system harness while working your way to the dash panel. Also wiggle, shake or bend the EEC-IV harness from the dash panel to the processor. • Is a fault indicated?	Yes ▶ No ▶	ISOLATE fault and make necessary repairs. REFER to appropriate figure. RERUN Quick Test. Go to **DH96**.
DH96 CHECK PROCESSOR AND HARNESS CONNECTORS		
• Key Off, wait 10 seconds. • Disconnect processor 60 Pin connector. • Inspect both connectors and connector terminals for obvious damage or faults. • Are connectors and terminals OK?	No ▶ Yes ▶	SERVICE as necessary. RERUN Quick Test. Unable to duplicate fault at this time. Continuous code 63 testing complete.

Vane Air Flow Sensor (VAF)	Pinpoint Test	DK

DK



* TEST PIN LOCATED ON BREAKOUT BOX
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

STOP-WARNING

You should enter this Pinpoint Test only when a service code 26, 56, 66 or 76 is received in Quick Test Step 3.0, 5.0 or 6.0.

To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

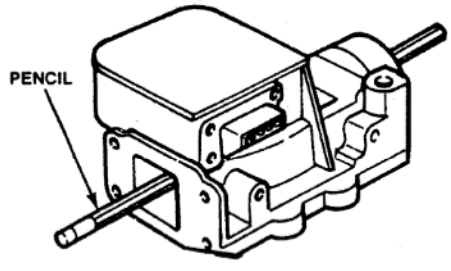
- Check for unmetered air (air leaks) between VAF meter and throttle body.
- Vacuum leaks.
- Engine sealing (PCV sealing, CANP, valve cover seal dipstick seated).

This Pinpoint Test is intended to diagnose only the following:

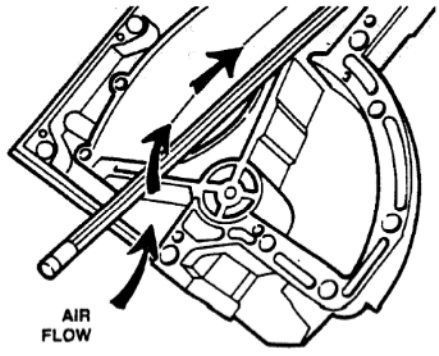
- VAF meter.
- Processor.
- Harness circuits: VREF, VAF Sig. and Signal Return.

Vane Air Flow Sensor (VAF) | Pinpoint Test | DK

TEST STEP	RESULT ▶	ACTION TO TAKE
FAULT CODE 26		
DK1 CHECK FOR CONTAMINATION		
NOTE: Code 26 (Key On, Engine Off, or Engine Running) indicates the vane air flow input to the processor is out of closed (Engine Not Running) or at idle limits (Engine Off 0.15-0.50V: Engine at Idle 1.50-2.70V). There have been no opens or shorts in the VAF circuit or a code 56 (signal always high) or 66 (signal always low) would have been generated.		
• Key Off, wait 10 seconds. • Remove air cleaner element and check for contamination (oil residue, foreign material, etc.) that may impede VAF sensor vane movement. • Is service code 26 present in Key On, Engine Off portion of Quick Test?	Yes ▶	REINSTALL air cleaner element. REPLACE vane meter. RERUN Quick Test.
	No ▶	GO to **DK2**.
DK2 VAF SENSOR CHECK		
• Key Off, air cleaner element reinstalled. • Check for unmetered air leaks between vane meter and throttle body. • Disconnect processor 60 Pin connector. Inspect for damaged pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout box. Connect processor to Breakout box harness. • DVOM on 20V scale. • Key On, engine Off. • Place new unsharpened pencil as shown below. • Measure voltage between test Pins 43 and 46 at the Breakout box. • Does DVOM read between 2.8V and 3.7V?	Yes ▶	Vane meter is capable of outputting an acceptable signal. The VAF code 26 has been caused by incorrect engine speed or an unmetered air leak (vacuum leak). SERVICE as necessary. REMOVE Breakout box. RERUN Quick Test.
	No ▶	REMOVE Breakout box. REPLACE processor. RERUN Quick Test.



VANE METER



VAF SENSOR AIR VANE

Vane Air Flow Sensor (VAF) | Pinpoint Test | DK

TEST STEP	RESULT ▶	ACTION TO TAKE
FAULT CODE 56		
DK10 INDUCE OPPOSITE CODE		
• Key Off, wait 10 seconds. • Disconnect vehicle harness from vane meter. Inspect for damaged pins, corrosion, loose wires, etc. Service as necessary. • Run Key On, Engine Off Quick Test. • Is code 66 present? **NOTE: Disconnecting vane meter disconnects both VAF and VAT sensors. A code 54 should also be present. Disregard all codes except VAF codes at this time.**	Yes ▶ No ▶	GO to **DK11**. GO to **DK12**.
DK11 CHECK VAF TO SIGNAL RETURN VOLTAGE		
• Key Off, wait 10 seconds. • Harness disconnected from vane meter. • Key On, Engine Off. • DVOM on 20V scale. • Measure voltage at the vane meter vehicle harness connector between VREF and Signal Return.	Reading is between 4.0V and 6.0V ▶ Reading is less than 4.0V or greater than 6.0V ▶	REPLACE vane meter. RECONNECT harness. RERUN Quick Test. GO to Pinpoint Test Step **C1**.
DK12 CHECK VAF SIGNAL FOR SHORT		
• Key Off, wait 10 seconds. • Harness disconnected from vane meter. • Disconnect processor 60 Pin connector. Inspect for damaged pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout box, leave processor disconnected. • DVOM on 200,000 ohm scale. • Measure resistance between test Pin 43 and test Pins 26 and 57 at the Breakout box.	Either reading is less than 10,000 ohms ▶ Both readings are 10,000 ohms or greater ▶	SERVICE circuit shorts. REMOVE Breakout box. RECONNECT processor and vane meter. RERUN Quick Test. REPLACE processor. REMOVE Breakout box. RECONNECT processor and vane meter. RERUN Quick Test.

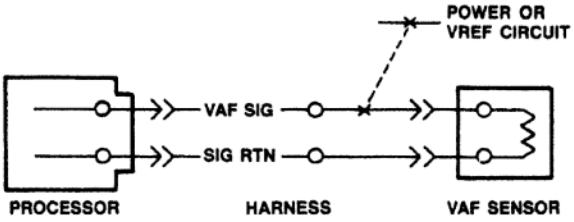
Vane Air Flow Sensor (VAF) — Pinpoint Test — DK

TEST STEP	RESULT ▶	ACTION TO TAKE
FAULT CODE 66		
DK20 INDUCE OPPOSITE CODE		
• Key Off, wait 10 seconds. • Disconnect vehicle harness from vane meter. • Install jumper wire in vane meter vehicle harness connector between VREF and VAF signal. • Perform Key On, Engine Off Quick Test. **NOTE: If no codes are generated, immediately remove jumper and go directly to DK23.** • Is code 56 present? **NOTE: Disconnecting vane meter disconnects both VAF and VAT sensors. Code 54 should also be present. Disregard all codes except VAF codes at this time.**	Yes ▶ No ▶	REPLACE vane meter. REMOVE jumper wire. RECONNECT vane meter. RERUN Quick Test. REMOVE jumper wire and GO to **DK21**.
DK21 CHECK VREF TO SIGNAL RETURN VOLTAGE		
• Key off, wait 10 seconds. • Harness disconnected from vane meter. • Key On, Engine Off. • DVOM on 20V scale. • Measure voltage at the vane meter vehicle harness connector between VREF and Signal Return.	Reading is between 4.0 and 6.0V ▶ Reading is less than 4.0V or greater than 6.0V ▶	GO to **DK22**. GO to Pinpoint Test Step **C1**.
DK22 CHECK CONTINUITY OF VAF SIGNAL		
• Key Off, harness disconnected from vane meter. • Disconnect processor 60 Pin connector. Inspect for damaged pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout box; leave processor disconnected. • DVOM on 200 ohm scale. • Measure resistance between VAF signal, at the vane meter vehicle harness connector, and test Pin 43 at the Breakout box.	Reading is less than 5 ohms ▶ Reading is 5 ohms or greater ▶	GO to **DK23**. SERVICE circuit open. REMOVE Breakout box. RECONNECT processor and vane meter. RERUN Quick Test.

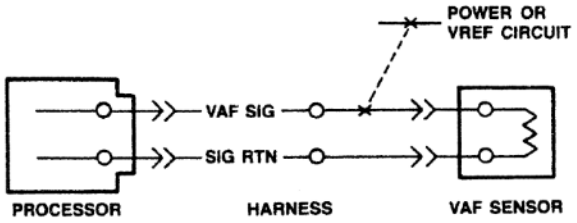
Vane Air Flow Sensor (VAF) | Pinpoint Test | DK

TEST STEP	RESULT ▶	ACTION TO TAKE
DK23 CHECK VAF SIGNAL FOR SHORT		
• Key Off, wait 10 seconds. • Processor disconnected. • Harness disconnected from vane meter. • DVOM on 200,000 ohm scale. • Measure resistance at the vane meter vehicle harness between VAF signal and signal return and between VAF signal and negative battery terminal.	Either reading is less than 10,000 ohms ▶	SERVICE circuit shorts. RECONNECT vane meter. RERUN Quick Test.
	Both readings are 10,000 ohms or greater ▶	REPLACE processor. REMOVE Breakout box. RECONNECT processor and vane meter. RERUN Quick Test.
FAULT CODE 76		
DK30 CHECK FOR VOLTAGE INCREASE IN VAF SIGNAL TO SIGNAL RETURN		
NOTE: A sharp snap of the throttle may not be sufficient to pass this test. Be sure to move throttle to WOT and return.		
• Key Off, wait 10 seconds. • Disconnect processor 60 Pin connector. Inspect for damaged pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout box. Connect processor to Breakout box harness. • DVOM on 20V scale. • Connect DVOM to test Pins 43 and 46. • Perform Engine Running Quick Test while monitoring DVOM. • After dynamic response prompt code 1(0) operator does a brief WOT. DVOM should increase more than 2.0V from reading before WOT. • Observe service codes at end of test.	Reading increased more than 2.0V and code 76 is still present ▶	REPLACE processor. REMOVE Breakout box. RERUN Quick Test.
	Reading did not increase more than 2.0V ▶	CHECK air cleaner duct for obstruction. If OK, REPLACE vane meter.
	Reading increased more than 2.0V and code 76 is not present ▶	Vane meter is OK, SERVICE other codes as necessary.

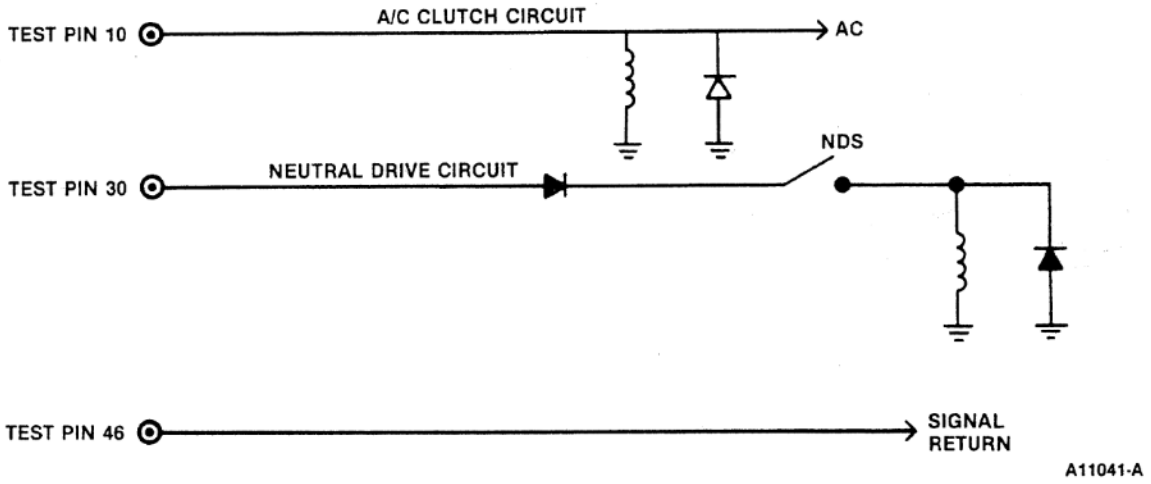
Vane Air Flow Sensor (VAF) | Pinpoint Test | DK

TEST STEP	RESULT ▶	ACTION TO TAKE
DK90 SERVICE CODE 56 CONTINUOUS TEST: CHECK VAF SENSOR		
• Using continuous monitor mode, observe VOM or STAR LED for indication of a fault while performing the following: • Lightly tap on VAF sensor (simulate road shock). • Wiggle VAF connector. • Is a fault indicated?  	Yes ▶ No ▶	DISCONNECT and INSPECT connectors. If connector and terminals are good, REPLACE VAF sensor. RERUN Quick Test. GO to **DK91**.
DK91 CHECK EEC-IV HARNESS		
• Observe VOM or STAR LED for a fault indication while performing the following: • Referring to the illustration in Step DK90, grasp the harness close to the sensor connector. Wiggle, shake or bend a small section of the EEC-IV system harness while working your way to the dash panel. Also wiggle, shake or bend the EEC-IV harness from the dash panel to the processor. • Is a fault indicated?	Yes ▶ No ▶	ISOLATE fault and make necessary repairs. REFER to appropriate figure. RERUN Quick Test. GO to **DK92**.
DK92 CHECK PROCESSOR AND HARNESS CONNECTORS		
• Key Off, wait 10 seconds. • Disconnect processor 60 Pin connector. • Inspect both connectors and connector terminals for obvious damage or faults. • Are connectors and terminals OK?	No ▶ Yes ▶	SERVICE as necessary. RERUN Quick Test. Unable to duplicate fault at this time. Continuous code 56 testing complete.

Vane Air Flow Sensor (VAF) | Pinpoint Test | DK

TEST STEP	RESULT ▶	ACTION TO TAKE
DK93 SERVICE CODE 66 CONTINUOUS TEST: CHECK VAF SENSOR		
• Using continuous monitor mode, observe VOM or STAR LED for indication of a fault while performing the following: • Lightly tap on VAF sensor (simulate road shock). • Wiggle VAF connector. • Is a fault indicated? 	Yes ▶ No ▶	DISCONNECT and INSPECT connectors. If connector and terminals are good, REPLACE sensor. RERUN Quick Test. GO to **DK94**.
DK94 CHECK EEC-IV HARNESS		
• Observe VOM or STAR LED for a fault indication while performing the following: • Referring to the illustration in Step DK93 grasp the harness close to the sensor connector. Wiggle, shake or bend a small section of the EEC-IV system harness while working your way to the dash panel. Also wiggle, shake or bend the EEC-IV harness from the dash panel to the processor. • Is a fault indicated?	Yes ▶ No ▶	ISOLATE fault and make necessary repairs. REFER to appropriate figure. RERUN Quick Test. Go to **DK95**.
DK95 CHECK PROCESSOR AND HARNESS CONNECTORS		
• Key Off, wait 10 seconds. • Disconnect processor 60 Pin connector. • Inspect both connectors and connector terminals for obvious damage or faults. • Are connectors and terminals OK?	No ▶ Yes ▶	SERVICE as necessary. RERUN Quick Test. Unable to duplicate fault at this time. Continuous code 66 testing complete.

Neutral Drive Switch A/C Input | Pinpoint Test | FA

TEST STEP	RESULT ▶	ACTION TO TAKE
FA1 CODE 67 SYSTEM IDENTIFICATION		
2.3L Turbo, M/T		GO to **FA15**.
2.3L Turbo A/T		GO to **FA2**.
FA2 NEUTRAL DRIVE INPUT CHECK		
		
• Key Off, wait 10 seconds. • Verify heater control is in OFF position, if so equipped. • Verify transmission is in NEUTRAL or PARK. • Disconnect processor 60 Pin connector and inspect for damaged pins, corrosion, loose wires. Service as necessary. • Install Breakout box. • Processor connected. • Key On, Engine Off. • DVOM on 20V scale. • Measure voltage between test Pin 30 (Neutral Drive circuit) at the Breakout box and chassis ground.	Less than 1.0V ▶ 1.0V or greater ▶	GO to **FA4**. GO to **FA3**.

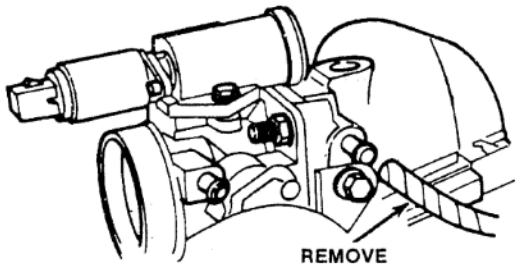
Neutral Drive Switch A/C Input

Pinpoint Test

FA

TEST STEP	RESULT ▶	ACTION TO TAKE
FA3 NEUTRAL DRIVE SWITCH CHECK		
• Key Off, wait 10 seconds. • Breakout box installed. • DVOM on 200 ohm scale. • Locate the Neutral Drive switch. • Disconnect vehicle harness from the Neutral Drive switch and measure resistance across the switch.	Less than 5 ohms ▶	SERVICE open in vehicle harness Neutral Drive circuit. RERUN Quick Test.
	5 ohms or greater ▶	REPLACE Neutral Drive switch. RERUN Quick Test.
FA4 A/C INPUT CHECK		
• Breakout box installed. • Key On, Engine Off. • DVOM on 20V scale. • A/C control Off. Measure voltage between test Pin 10 (A/C clutch circuit) at the Breakout box and chassis ground. **NOTE: On 2.3L Turbo, check for code 18 in continuous memory.**	1.0V or greater ▶	SERVICE short to power in A/C clutch circuit. RERUN Quick Test.
	Less than 1.0V ▶	REPLACE processor. RERUN Quick Test.

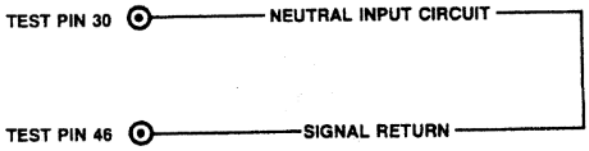
2.3L TURBO



REMOVE THIS HOSE FOR STEP HA10

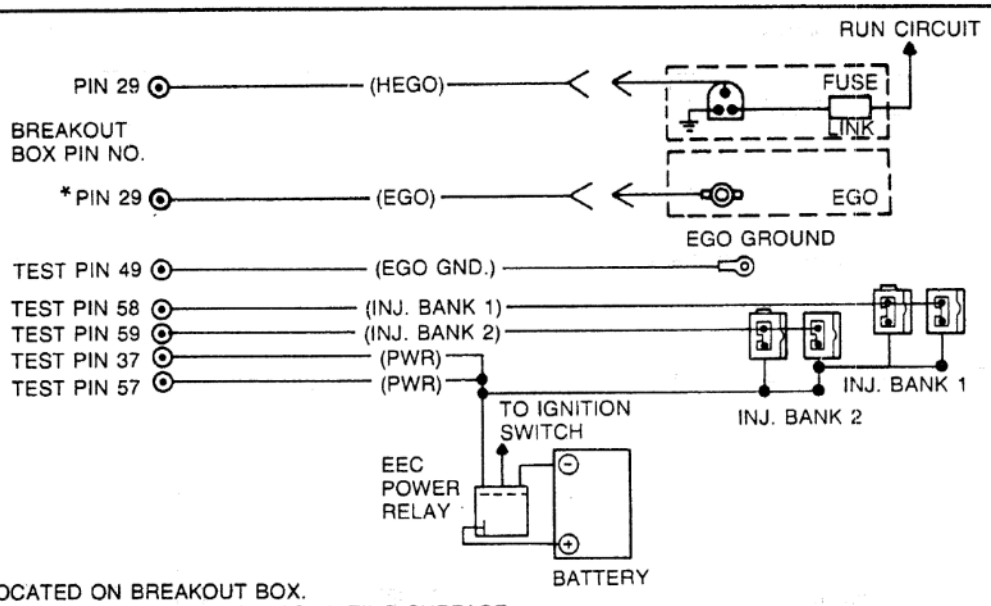
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Neutral Drive Switch A/C Input | Pinpoint Test | FA

TEST STEP	RESULT ▶	ACTION TO TAKE
FA15 NEUTRAL INPUT CHECK — 2.3L TC M/T		
		
• Key Off, wait 10 seconds. • Verify A/C is off, if so equipped. • Disconnect processor 60 Pin connector and inspect for damaged pins, corrosion, loose wires. Service as necessary. • Install Breakout box. • Leave processor disconnected. • DVOM on 200 ohm scale. • Measure resistance between test Pin 30 (Neutral Input circuit) and test Pin 46 (Signal Return circuit) at the Breakout box.	Less than 5 ohms ▶ 5 ohms or greater ▶	GO to **FA4**. SERVICE open in Neutral Input or Signal Return circuit. RERUN Quick Test.

Fuel Control — EFI | Pinpoint Test | HA

HA



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

STOP-WARNING

You should enter this Pinpoint Test Only when a Service Code 41 or 42 is received in Quick Test Step 5.0 or 6.0 or when directed here from Pinpoint Test A or Diagnostics by Symptom in the Engine Supplement Section.

To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

- Ignition Coil
- Distributor Cap
- Distributor Rotor
- Fouled Spark Plugs
- Spark Plug Wires
- CANP Problems
- PCV Valves (see note below)
- EGR Valve and Gasket
- Air Filter
- Fuel Contamination, Engine Oil
- Poor Power Ground
- Fuel Pressure
- Manifold Leaks, Intake/Exhaust
- Engine Not at Normal Operating Temperatures

This Pinpoint Test is intended to diagnose only the following:

- EGO Sensor
- Harness Circuits EGO Grd., EGO, INJ BANK 1, INJ BANK 2, V PWR
- EGO Sensor Connection
  - — Code 42 start at HA8
  - — Code 41 start at HA11
- Vacuum Systems
- Fuel Injectors
- Processor Assembly

NOTE: Fuel contaminated engine oil may affect 41, 42 Service Codes. If this is suspected, remove the PCV from the valve cover and repeat the Quick Test. If the problem is corrected, then change the engine oil and filter.

Fuel Control — EFI | Pinpoint Test | HA

TEST STEP	RESULT ▶	ACTION TO TAKE
HA1 FUEL PRESSURE CHECK 1		
• Key Off, wait 10 seconds. • Install fuel pressure gauge. • Start and run engine. Fuel pressure must be 241-310 kPa (30-35 psi). **For No Starts:** • If engine will not run, cycle the key from Off to On several times to increase fuel pressure.	Yes ▶ No ▶	GO to **HA2**. REFER to Group 24 for electric fuel pump and for fuel pressure regulator check.
HA2 FUEL PRESSURE CHECK 2		
• Fuel pressure must remain at 276 ± 34 kPa (30 psi ± 5 psi) for 60 seconds or longer after final Key Off.	Yes ▶ No ▶	GO to **HA3**. GO to **HA7**.
HA3 FUEL DELIVERY TEST		
• Key Off. • Fuel pressure gauge installed. • Pressurize fuel system as per Step HA1 • Locate and disconnect the fuel pump relay. • Crank engine for 5 seconds. • Take pressure reading at the end of 5 second crank. **NOTE: Verify fuel quality; air and/or water will also pressurize and look like acceptable fuel delivery.**	PRESSURE GAUGE READING: Pressure is approximately 10-20 psi at the end of 5 second crank cycle. Refer to note below. ▶ Pressure is greater or less than specified ▶	The EEC system is not the fault of the No Start. Fuel and spark are present. REFER to Section 2 for other No Start Routines. If complaint was runs rough/ misses or fuel code GO to **HA4**. GO to **HA4**.

NOTE: The colder the engine, the greater the pressure drop (i.e., an engine coolant temperature of 200°F equals approximately a 10 psi drop in 5 seconds. 60°F equals approximately a 20 psi drop in 5 seconds).

Fuel Control — EFI | Pinpoint Test | HA

TEST STEP	RESULT ▶	ACTION TO TAKE
HA4 HARNESS INJECTOR RESISTANCE CHECK		
• Key Off, wait 10 seconds. • Disconnect processor 60 Pin connector and inspect for damaged pins, corrosion, loose wires. Service as necessary. • Connect Breakout box to harness. Leave processor disconnected. • DVOM on 200 ohm scale. • Measure the resistance of injector Bank 1 (1&2) between test Pin 37 and test Pin 58 at the breakout box. Record reading. • Measure the resistance of injector Bank 2 (3&4) between test Pin 37 and test Pin 59 at the Breakout box. Record reading. • Are both readings between 1.2 ohms and 1.8 ohms?	Yes ▶ No ▶	GO to **HA6**. GO to **HA5**.
HA5 ISOLATE FAULTY INJECTOR CIRCUIT		
• Key Off. • Breakout box installed. • Leave processor disconnected. • DVOM on 200 ohm scale. • Disconnect all injectors on suspect Bank. Measure resistance of each injector by connecting one injector at a time, and reading the resistance between test Pins 37 and 58 at the Breakout box for Bank 1 (1&2) or test Pins 37 and 59 at the breakout box for Bank 2 (3&4). • Are all readings between 2.0 and 2.7 ohms?	Yes ▶ No ▶	GO to **HA6**. SERVICE the harness/connectors on the suspect injector for opens or shorts. If OK, REPLACE injector. RERUN Quick Test.

Fuel Control — EFI | Pinpoint Test | HA

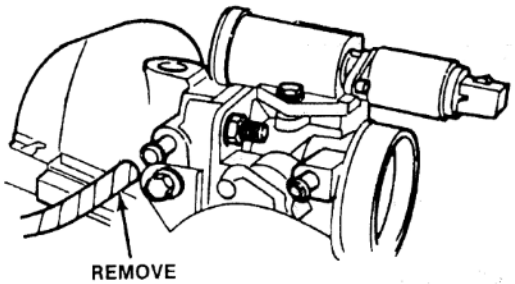
TEST STEP	RESULT ▶	ACTION TO TAKE
HA6 INJECTOR DRIVE SIGNAL CHECK		
Requires standard non-powered 12 volt test lamp. • Key Off. • Breakout box installed. • Connect processor to Breakout box. • Connect test lamp between test Pin 37 and test Pin 58 at the Breakout box. • Crank or start engine. • Repeat above test between test Pin 37 and test Pin 59 at the Breakout box.	Dim glow at light on both tests ▶	GO to **HA7**.
	No light on one or both tests ▶	VERIFY 12-volt battery power at Pins 37 and 57. If OK, REPLACE processor. RERUN Quick Test.
	Bright light on one or both tests ▶	CHECK circuits Bank 1 and Bank 2 for shorts to ground. If OK, REPLACE processor. RERUN Quick Test.
HA7 INJECTOR BALANCE TEST		
• Connect tachometer to engine. Disconnect ISC. Run engine at 2000 rpm. Use throttle body stop screw to set engine speed. • Disconnect and reconnect the injectors one at a time; note rpm drop for each injector. • Does each injector produce at least a 150 rpm drop? • Reconnect ISC. Reset curb idle. Refer to VECI decal.	Yes ▶	Fuel delivery OK. Problem is with area common to all cylinders, i.e.: Air/ vacuum leak, fuel contamination, EGR.
	No ▶	REPLACE faulty injector. RERUN Quick Test.
HA8 FUEL CONTROL — ALWAYS RICH: CODE 42		
• Key Off, wait 10 seconds. • **NOTE: Non-EEC areas could cause a code 42.** **Check for:** **— Fuel contaminated engine oil** **— Ignition caused misfire** **— CANP problems** • Disconnect vehicle harness at the EGO sensor. Using a jumper wire, ground vehicle harness EGO circuit at the EGO sensor to the engine block. • Repeat Engine Running Self-Test. • Service code 41 results.	Yes ▶	GO to **HA10**.
	No ▶	GO to **HA9**.

Fuel Control — EFI

Pinpoint Test HA

TEST STEP	RESULT	ACTION TO TAKE
HA9 HARNESS CHECK		
• Key Off, wait 10 seconds. • Install Breakout box. • Measure resistance of EGO ground circuit between test Pin 49 at the Breakout box and EGO ground at engine block. • Measure resistance of EGO circuit between test Pin 29 at the Breakout box and EGO harness connector. • Both circuits less than 5 ohms.	Yes ▶	DISCONNECT processor connector. INSPECT for damage or corrosion. If OK, REPLACE processor. RERUN Quick Test.
	No ▶	CORRECT harness circuit with resistance greater than 5 ohms. RERUN Quick Test.
HA10 EGO CHECK		
• DVOM on 20V scale. • With EGO sensor disconnected from the vehicle harness, connect a DVOM from EGO sensor to engine ground. • Run the engine at 2000 rpm for 1 minute. While observing DVOM, disconnect the manifold vacuum hose indicated below. • Meter indicates less than 0.4V.	Yes ▶	EGO sensor OK. GO to **HA1**.
	No ▶	REPLACE EGO sensor. RERUN Quick Test.

2.3L TURBO



A11046-A

Fuel Control — EFI

Pinpoint Test HA

TEST STEP	RESULT ▶	ACTION TO TAKE
HA11 FUEL CONTROL — ALWAYS LEAN: CODE 41		
NOTE: Vacuum/air leaks in non-EEC areas could cause a code 41. Check for: **— Leaking vacuum actuator (eg: A/C control motor)** **— Engine sealing** **— EGR system** **— PCV system** **— Unmetered air leak between air meter and throttle body** **— Lead contaminated EGO sensor** • Key Off. DVOM on 20V scale. Disconnect EGO sensor from vehicle harness. Connect DVOM to EGO sensor and engine ground. Remove air cleaner to gain access to air meter inlet. Using a standard wood lead pencil, prop the air meter door part-way open. • Start the engine and run at approximately 2000 rpm for 2 minutes. • Does the DVOM read greater than 0.5V at the end of 1 minute?	Yes ▶ No ▶	GO to **HA12**. REPLACE EGO sensor. RERUN Quick Test.
HA12 HARNESS CHECK EGO CIRCUITS		
• Key Off. • Install Breakout box. Processor disconnected. • Measure resistance of EGO circuit between test Pin 49 at the Breakout box and engine block ground. Also EGO circuit between EGO connector and test Pin 29 at the Breakout box. • Are both circuits less than 5 ohms?	Yes ▶ No ▶	GO to **HA13**. SERVICE/CORRECT as necessary any circuit greater than 5 ohms. RERUN Quick Test.
HA13 CHECK EGO CIRCUIT FOR SHORT TO GROUND		
• Key Off. • Breakout box installed. Processor disconnected. • DVOM to 200,000 ohms scale. • Measure the resistance between test Pin 29 and test Pin 40 at the Breakout box.	Reading is 10,000 ohms or greater ▶ Reading is less than 10,000 ohms ▶	GO to **HA14**. CORRECT cause of resistance to ground. RERUN Quick Test.

Fuel Control — EFI | Pinpoint Test | HA

TEST STEP	RESULT ▶	ACTION TO TAKE
HA14 ATTEMPT TO ELIMINATE CODE 41		
• Key Off. • Reconnect EGO sensor. Remove air cleaner to gain access to air meter inlet. Using a standard wood lead pencil, prop the air meter door part-way open. • Start the engine and run at approximately 2000 rpm for 2 minutes. • Perform Engine Running Quick Test. • Is code 41 present?	Yes ▶	INSPECT for corrosion or damaged pins. If OK, REPLACE processor. RERUN Quick Test.
	No ▶	EGO input circuit OK. GO to **HA1**.

Fuel Control — EFI | Pinpoint Test | HA

HA20 CONTINUOUS TESTING: CODE 41/42

41 — EGO indicated the fuel system was lean for more than 15 seconds when the system should have been in closed loop fuel control.

42 — EGO indicated the fuel system was rich for more than 15 seconds when the system should have been in closed loop fuel control.

*CLOSED LOOP — Fuel control under the influence of the EGO sensor.

*OPEN LOOP — Fuel control NOT under the influence of the EGO sensor.

Before attempting to correct a fuel control code, 41/42, diagnose all other drive complaints first, eg., rough idle, misses, etc.

NOTE: The fuel control code may help in this diagnosis.

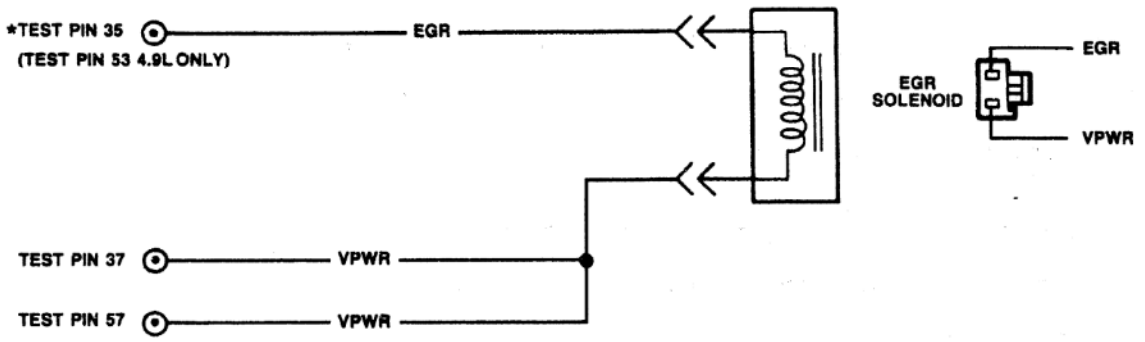
Using the fuel control service code, isolate the cause of the fuel control problem.

Some areas to check are:

- Unmetered Air: Vacuum leaks/intake air leaks.
  — Canister Purge System.
  — PCV System.
  — Engine sealing.
  — Air leaks between VAF meter and throttle body.
- EGO Fuel Fouled: Whenever an over-rich fuel condition has been experienced (fuel fouled spark plugs), make a thorough check of the ignition system. In the event the EGO sensor is suspected of being fuel fouled (low output, slow response), run the vehicle at sustained high speeds (within legal limits) followed by a few hard accelerations. This will burn off EGO contamination and restore proper EGO operation.
- Fuel Pressure: Perform Pinpoint Test Step **HA1**.
- Ignition System: Always in default spark (10 degrees). Refer to Quick Test Step **4.0**
- Improper Fueling: Lead fouled EGO sensor.
- TP Sensor: Not moving (mechanical damage). Connect DVOM to test Pin 47 and to test Pin 46. Key to Run. Observe DVOM while moving the throttle. Reading must increase with increase in throttle opening. If not correct, REPLACE as necessary.
- If at this point, the drive concern is still present, perform Steps **HA3** through **HA6** only.

EGR On/Off Control	Pinpoint Test	KA

KA



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

STOP-WARNING

You should enter this Pinpoint Test only when a service code 34 is received in Quick Test Step 5.0 or when directed here from Diagnostic by Symptom in the Engine Supplement Section.

To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

- Air or Vacuum Leaks
- EGR Flow Restrictions
- EGR Value

NOTE: Code 34 may be the result of high volume exhaust vent system (reduces backpressure). If this is suspected, perform the test in a well-ventilated area without exhaust vent connected.

This Pinpoint Test is intended to diagnose only the following:

- Circuits: EGR and VPWR
- EGR Solenoid
- Presence of Manifold Vacuum
- Processor Assembly

EGR On/Off Control | Pinpoint Test | KA

TEST STEP	RESULT ▶	ACTION TO TAKE
KA1 ENTER OUTPUT STATE CHECK (REFER TO APPENDIX) **NOTE: Do not use STAR tester for this step, use a VOM/DVOM.** • Key Off, wait 10 seconds. • DVOM on 20V scale. • Connect DVOM negative test lead to STO at the Self-Test connector and positive test lead to battery positive. • Jumper STI to signal return at the Self-Test connector. • Perform Key On, Engine Off Self-Test until the completion of the Continuous Test Codes. • DVOM will indicate zero volts. • Depress and release the throttle. • Did DVOM reading change to a high voltage reading?	Yes ▶ No ▶	REMAIN in Output State Check. GO to **KA2**. DEPRESS throttle to WOT and release. If STO voltage does not go high, GO to Pinpoint Test Step **Q40**. Leave equipment hooked up.
KA2 CHECK EGR ON/OFF CONTROL SOLENOID ELECTRICAL OPERATION • DVOM on 20V scale. • Connect DVOM positive test lead to VPWR circuit on EGR solenoid and negative test lead to EGR output circuit. • While observing DVOM, depress and release the throttle several times to cycle output On and Off. • EGR output cycles On and Off.	Yes ▶ No ▶	GO to **KA3**. REMOVE jumper. GO to **KA5**.
KA3 CHECK SOLENOID FOR VACUUM CYCLING • Install vacuum pump to the solenoid vacuum supply port and install a vacuum gauge to the output port. Apply 6 in. Hg minimum. • While cycling outputs On and Off (by depressing and releasing throttle) observe the vacuum gauge at the output. **NOTE: Maintain vacuum at source.**	Vacuum output cycles On and Off ▶ Vacuum output does not cycle On and Off ▶	GO to **KA4**. REPLACE solenoid. RERUN Quick Test.

EGR On/Off Control — Pinpoint Test — KA

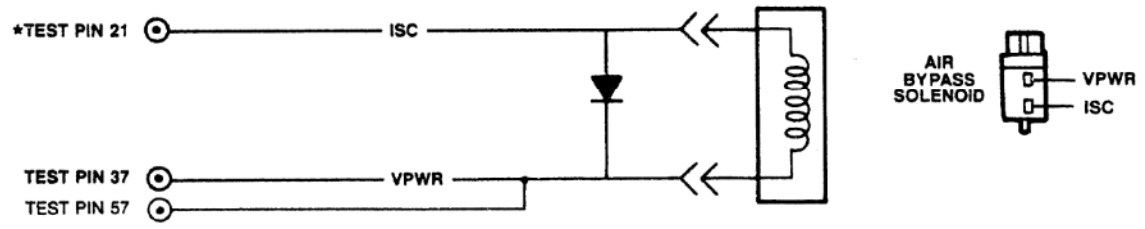
TEST STEP	RESULT ▶	ACTION TO TAKE
KA4 CHECK MANIFOLD VACUUM LINES FOR BLOCKAGE OR LEAKS		
• Vacuum lines disconnected at solenoid. • Start engine. • Check for vacuum.	Vacuum present ▶	EEC-IV system OK. REFER to Section 6.
	No vacuum present ▶	SERVICE vacuum source blockage or leak. RERUN Quick Test.
KA5 MEASURE EGR SOLENOID RESISTANCE		
• Key Off, wait 10 seconds. • DVOM on 200 ohm scale. • Disconnect EGR solenoid connector and measure solenoid resistance.	Resistance is between 65 and 110 ohms ▶	CONNECT EGR solenoid. GO to **KA6**.
	Resistance is less than 65 ohms or greater than 110 ohms ▶	REPLACE EGR solenoid. RERUN Quick Test.
KA6 CHECK VOLTAGE OF VPWR CIRCUIT		
• Key On, Engine Off. • DVOM on 20V scale. • Measure voltage between VPWR circuit at the EGR solenoid vehicle harness connector and battery ground.	Voltage reading is less than 10.5V ▶	SERVICE harness open circuit. RERUN Quick Test.
	Voltage reading is 10.5V or greater ▶	GO to **KA7**.
KA7 CHECK CONTINUITY OF EGR CIRCUIT		
• Key Off, wait 10 seconds. • Disconnect processor 60 Pin connector and inspect for damaged pins, corrosion, loose wires. Service as necessary. • Connect Breakout box to harness. Leave processor disconnected. • DVOM on 200 ohm scale. • Measure resistance between test Pin 35 at the Breakout box and EGR circuit at vehicle harness connector.	Resistance reading is 5 ohms or greater ▶	SERVICE open circuit. RERUN Quick Test.
	Resistance reading is less than 5 ohms ▶	GO to **KA8**.

EGR On/Off Control | Pinpoint Test | KA

TEST STEP	RESULT ▶	ACTION TO TAKE
KA8 CHECK FOR SHORT TO GROUND		
• Key Off, wait 10 seconds. • Leave Breakout box installed and processor disconnected. • Disconnect EGR solenoid. • DVOM on 200,000 ohm scale. • Measure resistance between test Pin 35 and test Pins 40, 46 and 60 at the Breakout box.	Resistance reading is less than 10,000 ohms ▶	SERVICE short to ground. RERUN Quick Test.
	Resistance reading is 10,000 ohms or greater ▶	GO to **KA9**.
KA9 CHECK FOR SHORT TO POWER		
• Key Off, wait 10 seconds. • DVOM on 200,000 ohm scale. • Leave Breakout box installed and processor disconnected. • EGR solenoid disconnected. • Measure resistance between test Pin 35 and test Pins 37 and 57 at the Breakout box.	Resistance reading is 10,000 ohms or greater ▶	REPLACE Processor. RERUN Quick Test.
	Resistance reading is less than 10,000 ohms ▶	SERVICE short to power. RERUN Quick Test. If code is repeated, REPLACE processor.

Idle Speed Control (By-Pass Air)	Pinpoint Test	KE

KE



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

STOP-WARNING

You should enter this Pinpoint Test only when a service code 12 or 13 is received in Quick Test Step 5.0 or when directed here from Diagnostic by Symptom in the Engine Supplement Section.

CAUTION: If the engine exhibits rough running and/or idle, correct these conditions before diagnosing Idle Speed Control (ISC). Rough running/misses may be caused by:

- **Ignition System**
  Refer to Section 23
- **Fuel System**
  Refer to Pinpoint Test Steps HA1 through HA7
  Refer to Pinpoint Test Steps HE1 through HE7.
  Refer to Pinpoint Test Steps HG1 through HG6.
  Refer to Pinpoint Test Steps HL2 through HL7.
- **EGR System, Section 3**

To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

- Engine not up to operating temperature
- Engine over operating temperature
- Improper Idle Speed Throttle Stop Adjustment
- A/C input (electrical problem)
- Throttle Speed Control Linkage

This Pinpoint Test is intended to diagnose only the following:

- RPM in Self-Test only
- ISC Actuator
- Harness Circuits ISC and VPWR
- Processor Assembly

Idle Speed Control (By-Pass Air) — Pinpoint Test — KE

TEST STEP	RESULT ▶	ACTION TO TAKE
KE1 RPM DROP		
• Key Off. • Connect engine tachometer. • Start engine. • Disconnect ISC harness connector. • Does rpm drop or stall?	Yes ▶ No ▶	GO to **KE2**. GO to **KE3**.
KE2 CHECK FOR EGR CODES		
• Are service codes 31, 32, 33 or 34 present?	Yes ▶ No ▶	GO to Quick Test Step 5.0 for appropriate Pinpoint Test. SERVICE next code or if code 12 or 13 only, GO to **KE3**.
KE3 MEASURE ISC SOLENOID RESISTANCE		
• Key Off. • DVOM on 200 ohm scale. • Disconnect ISC solenoid connector and measure solenoid resistance.	Resistance is between 7 and 13 ohms ▶ Resistance is less than 7 ohms or greater than 13 ohms ▶	GO to **KE4**. REPLACE ISC solenoid. RERUN Quick Test.
KE4 ISC SHORT TO CASE (GROUND) CHECK		
• Key Off. • DVOM on 200,000 ohm scale. • ISC solenoid disconnected. • Measure resistance from either ISC pin to ISC housing.	10,000 ohms or greater ▶ Less than 10,000 ohms ▶	GO to **KE5**. REPLACE ISC solenoid. RERUN Quick Test.
KE5 CHECK VOLTAGE OF VPWR CIRCUIT		
• Key On, Engine Off. • DVOM on 20V scale. • ISC solenoid disconnected. • Measure voltage between VPWR at the ISC solenoid harness connector and battery ground.	Voltage reading is less than 10.5V ▶ Voltage reading is 10.5V or greater ▶	SERVICE harness open circuit. RERUN Quick Test. GO to **KE6**.

Idle Speed Control (By-Pass Air) — Pinpoint Test KE

TEST STEP	RESULT ▶	ACTION TO TAKE
KE6 CHECK CONTINUITY OF ISC CIRCUIT • Key Off, wait 10 seconds. • ISC solenoid disconnected. • Disconnect processor and inspect both 60 Pin connectors for damaged pins, corrosion, loose wires. Service as necessary. • Connect Breakout box to harness. Leave processor disconnected. • DVOM on 200 ohm scale. • Measure resistance between test Pin 21 at the Breakout box and ISC circuit at vehicle harness connector.	Resistance reading is 5 ohms or greater ▶ Resistance reading is less than 5 ohms ▶	SERVICE open circuit. RERUN Quick Test. GO to **KE7**.
KE7 CHECK FOR SHORT TO GROUND • Key Off, wait 10 seconds. • Leave Breakout box installed and processor disconnected. • ISC solenoid disconnected. • DVOM on 200,000 ohm scale. • Measure resistance between test Pin 21 and test Pins 40, 46 and 60 at the Breakout box.	All resistance readings are less than 10,000 ohms ▶ Any resistance reading is 10,000 ohms or greater ▶	SERVICE short to ground. RERUN Quick Test. GO to **KE8**.
KE8 CHECK FOR SHORT TO POWER • Key Off, wait 10 seconds. • DVOM on 200,000 ohm scale. • ISC solenoid disconnected. • Leave Breakout box to connected harness. Leave processor disconnected. • Measure resistance between test Pin 21 and test Pin 37 at the Breakout box.	Resistance reading is 10,000 ohms or greater ▶ Resistance reading is less than 10,000 ohms ▶	GO to **KE9**. SERVICE short to power. RERUN Quick Test.
KE9 CHECK FOR ISC SIGNAL AT THE PROCESSOR • Connect processor. • Connect ISC actuator. • Vehicle prepared for Quick Test. • DVOM on 20V scale. • Connect DVOM between test Pin 21 and test Pin 40. • Start engine and observe the DVOM during Engine Running Quick Test.	Meter reading varies during Quick Test ▶ Meter reading does not vary during Quick Test ▶	REPLACE ISC actuator. RERUN Quick Test. GO to **KE10**.

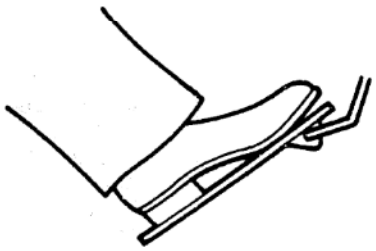
Idle Speed Control (By-Pass Air) — Pinpoint Test — KE

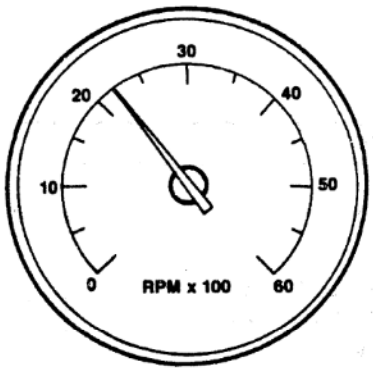
TEST STEP	RESULT ▶	ACTION TO TAKE
KE10 **CODE 13:** RPM DOES NOT DROP TO LESS THAN 1500 AT END OF TEST		
• Disconnect ISC harness connector. • Connect engine tachometer. • Repeat Engine Running Quick Test. • At end of test, record service codes for future use. • Does rpm remain below 1500 rpm during test?	Yes ▶	REPLACE processor. RERUN Quick Test.
	No ▶	CHECK engine vacuum hoses. REFER to VECI decal. VERIFY curb idle. CHECK that throttle plates are fully closed, CHECK throttle linkage and/or speed control linkage for binding. If OK, REPLACE ISC actuator. RERUN Quick Test.
KE11 CURB IDLE CHECK		
• Key Off, wait 10 seconds. • Deactivate Self-Test. • Run engine at 2000 rpm for 2 minutes or until inlet radiator hose is hot and pressurized. • Key Off, wait 10 seconds. • Activate Self-Test. • Run Engine Running Self-Test. • Is code 17 still present?	No ▶	SERVICE other codes as necessary.
	Yes ▶	INSPECT throttle body and air inlet for contamination. SERVICE as necessary. If OK, ADJUST curb idle (REFER to Section 4 for procedure). RERUN Quick Test.

Dynamic Response Test	Pinpoint Test	M

M

OPERATOR PERFORMS BRIEF WOT





RPM INCREASE
GREATER THAN 2000 RPM

STOP-WARNING

You should enter this Pinpoint Test only when a service code 77 is received in Quick Test Step 5.0.

To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

- Operator did not perform a brief WOT after dynamic response code.
- Mechanical engine problems; engine did not achieve greater than 2000 rpm.

This Pinpoint Test is intended to diagnose only the following:

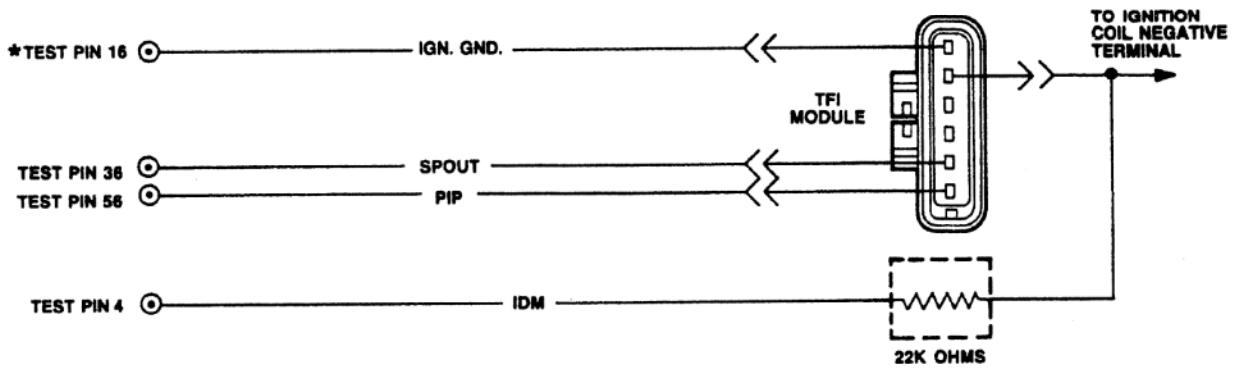
- Throttle movement (greater than 3/4 throttle).
- Vane Air Flow (greater than 50% open).
- RPM increase (greater than 2000 rpm).

Dynamic Response Test | Pinpoint Test | M

TEST STEP		RESULT ▶	ACTION TO TAKE
M1	CODE 77: SYSTEM FAILED TO RECOGNIZE BRIEF WOT		
NOTE: A brief snap of the throttle may not be sufficient to pass this test. Be sure to go to WOT and return.			
• Repeat Engine Running Test of Quick Test. Be sure operator is familiar with the engine running format which proceeds as follows: — With Self-Test activated restart the engine. — ID Code 2 (0) start of test. — Dynamic response Code 1 (0) perform brief WOT. — Testing over. — Service code output begins.		Code 77 still present ▶ No Code 77 ▶	REPLACE processor. RERUN Quick Test. Dynamic Response Test passed. SERVICE any other service code(s) received as necessary.

Ignition Diagnostic Monitor (IDM)	Pinpoint Test	N

N



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

STOP-WARNING

You should enter this Pinpoint Test only when a service code 18 is received in Quick Test Step 6.0.

To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

- Ignition module.
- Ignition coil.
- Spark plugs and high tension cables.
- Distributor and PIP sensor.

This Pinpoint Test is intended to diagnose only the following:

- Harness circuits: ignition ground, spout, PIP, IDM.

Ignition Diagnostic Monitor (IDM) | Pinpoint Test | N

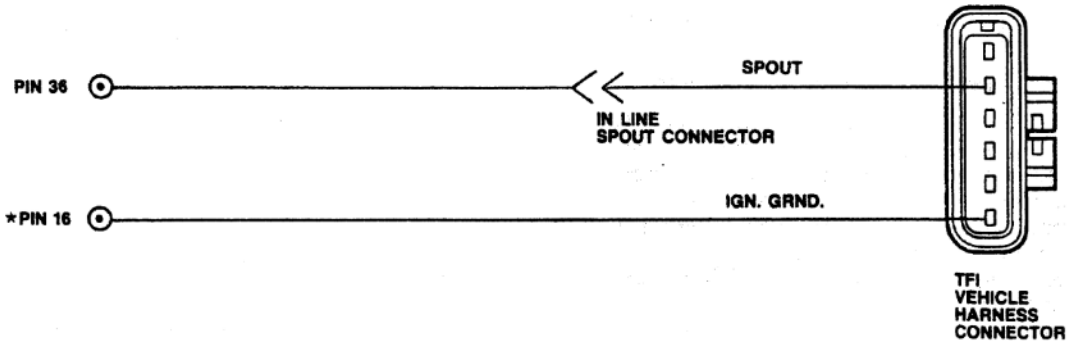
TEST STEP	RESULT ▶	ACTION TO TAKE
N1 CHECK CONTINUITY OF IDM CIRCUIT • Key Off, wait 10 seconds. • Disconnect E-core ignition connector from coil. • Disconnect processor and inspect both 60 Pin connectors for damaged pins, corrosion, loose wires. Service as necessary. • Connect Breakout box to harness. Leave processor disconnected. • DVOM on 200,000 ohm scale. • Measure resistance between test Pin 4 at the Breakout box and ignition coil negative terminal.	Resistance reading is less than 20,000 ohms or greater than 24,000 ohms ▶ Resistance reading is less than 24,000 ohms but greater than 20,000 ohms ▶	SERVICE open circuit. RERUN Quick Test. GO to **N2**.
N2 CHECK FOR SHORT TO GROUND • Key Off, wait 10 seconds. • Leave Breakout box installed and processor disconnected. • DVOM on 200,000 ohm scale. • Measure resistance between test Pin 4 and test Pins 40, 46 and 60 at the Breakout box.	Any resistance reading is less than 10,000 ohms ▶ All resistance readings are 10,000 ohms or greater ▶	SERVICE short to ground. RERUN Quick Test. GO to **N3**.
N3 CHECK TFI MODULE • Key Off, wait 10 seconds. • Deactivate Self-Test. • Connect VOM or STAR per Quick Test Step 2.0. • Enter Engine Running Continuous Monitor Test (as instructed in Quick Test Step 6.0D). • Observe VOM or STAR LED for indication of a fault while performing the following: • Lightly tap on TFI module (simulate road shock). • Wiggle TFI connector. • Is a fault indicated?	Yes ▶ No ▶	DISCONNECT and INSPECT connectors. If connector and terminals are good, GO to Section 15, TFI Ignition Diagnostics. GO to **N4**.

Ignition Diagnostic Monitor (IDM) | Pinpoint Test | N

TEST STEP	RESULT ▶	ACTION TO TAKE
N4 CHECK EEC-IV HARNESS		
• While still in continuous monitor test from step N1 observe VOM or STAR LED for a fault indication while performing the following: • While looking for faults listed in the table below, grasp the harness close to the TFI connector. Wiggle, shake or bend a small section of the EEC-IV system harness while working your way to the dash panel. Also wiggle, shake or bend the EEC-IV harness from the dash panel to the processor. Do this test on the circuits listed one at a time if needed to locate a faulty circuit. **FAULT** — **BREAKOUT BOX NO.** PIP shorted to ground or open — Test Pin 56 Spout shorted to ground — Test Pin 36 Ign. ground open — Test Pin 16 IDM open or shorted to ground, power — Test Pin 4 • Is a fault indicated?	Yes ▶ No ▶	ISOLATE fault and make necessary repairs. RERUN Quick Test. GO to **N5**.
N5 CHECK PROCESSOR AND HARNESS CONNECTORS		
• Key Off, wait 10 seconds. • Disconnect processor 60 Pin connector and inspect for damaged pins, corrosion, loose wires. • Are connectors and terminals OK? • Reconnect processor when this Step is completed.	No ▶ Yes ▶	SERVICE as necessary. RERUN Quick Test. If unable to DUPLICATE an IDM fault in the EEC-IV System, testing is complete.

Spark Timing Check	Pinpoint Test	P

P



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

STOP-WARNING

You should enter this Pinpoint Test only when directed here from Quick Test Step 4.0.

To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

- Base Engine.
- PIP Sensor.
- TFI Module.

This Pinpoint Test is intended to diagnose only the following:

- Harness Spout Circuit.
- Base Timing.
- Processor Assembly.

Spark Timing Check | Pinpoint Test | P

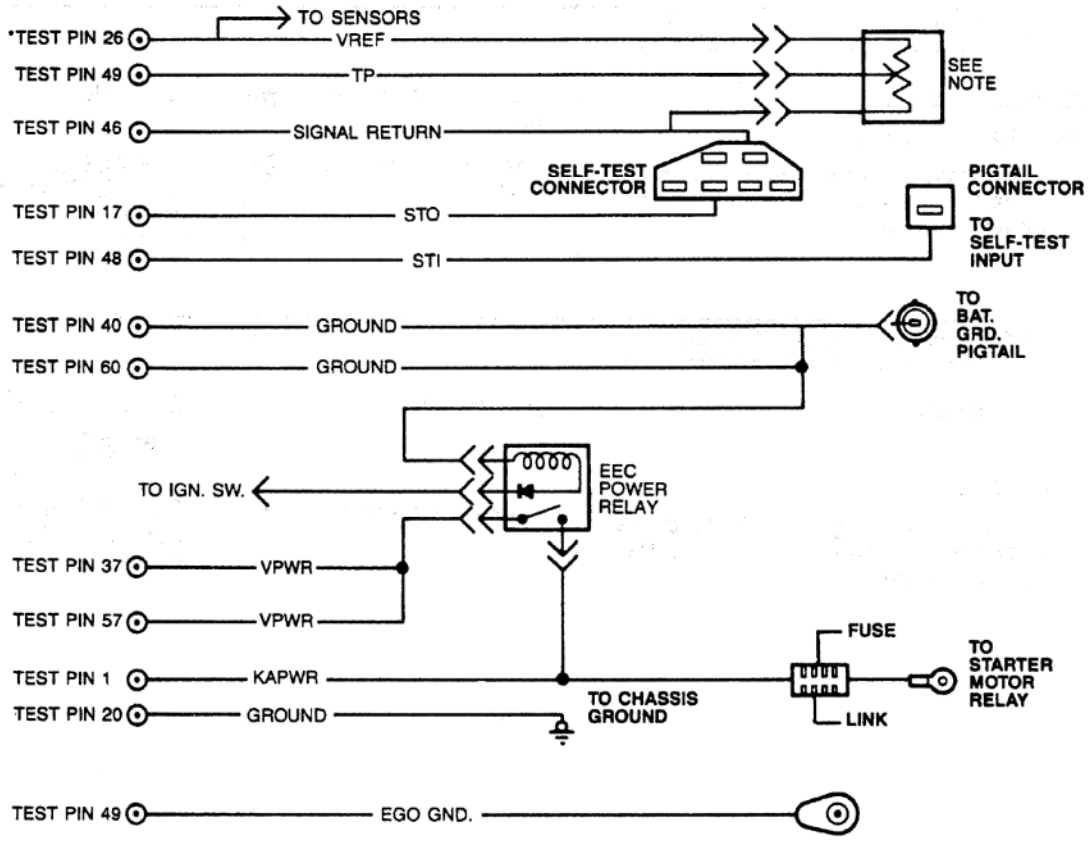
TEST STEP	RESULT ▶	ACTION TO TAKE
P1 CHECK SPARK TIMING • Verify that Self-Test is activated during Engine Running Test. • Check timing while performing Engine Running Test. Record value. • Timing base plus 20 degrees ± 3 degrees? **NOTE: Self-Test locks the timing at 20 degrees plus base throughout this test and for two minutes after the last service code is outputted. Timing check must be made during this time period. Self-Test timing is base +20 degrees (±3 degrees) BTDC. (See VECI decal for base value.)**	Yes ▶ No ▶	GO to Quick Test Step [5.0]. GO to [P2].
P2 CHECK SPARK OUTPUT (SPOUT) CIRCUIT TO THE TFI MODULE • Locate spout connector and open this connection. • Start engine. • Check base timing. • Timing base ±3 degrees BTDC. **NOTE: Base timing must be checked to decal value.**	Yes ▶ No ▶	GO to [P3]. Adjust base timing if necessary. REFER to Section 15 for engine timing instructions. After timing is reset, RECONNECT spout and PERFORM Quick Test Step [4].
P3 CHECK FOR POWER TO PROCESSOR • Key Off, wait 10 seconds. • Disconnect processor 60 Pin connector and inspect for damaged pins, corrosion, loose wires. Service as necessary. • Install Breakout Box. • Key On, Engine Off. • DVOM on 20V scale. • Measure voltage between test Pin 37 and test Pin 40 and between test Pin 57 and test Pin 60 at the Breakout box.	Either voltage reading less than 10.5V ▶ Both voltage readings 10.5V or greater ▶	GO to Pinpoint Test Step [B1]. GO to [P4].

Spark Timing Check | Pinpoint Test | P

TEST STEP	RESULT ▶	ACTION TO TAKE
P4 CHECK HARNESS FOR CONTINUITY		
• Key Off, wait 10 seconds. • DVOM on 200 ohm scale. • Measure resistance between test Pin 36 at the Breakout box and Pin 2 (spout pin) at the TFI vehicle harness connector.	Reading 5 ohms or less ▶	GO to **P5**.
	Reading greater than 5 ohms ▶	SERVICE open circuit. CONNECT spout test connector. CHECK timing per **P1**.
P5 HARNESS CHECK — IGNITION GROUND		
• Breakout box installed. • Key Off. • DVOM on 200 ohm scale. • Measure resistance between test Pin 16 at the Breakout box and TFI Pin 6 (ign. grnd.) at the TFI vehicle harness connector.	Less than 5 ohms ▶	GO to Pinpoint Test Step **A7**.
	5 ohms or greater ▶	SERVICE harness as necessary. RERUN Quick Test.

No Codes/Codes Not Listed	Pinpoint Test	Q

Q



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

NOTE: REFER TO THE ELECTRICAL SCHEMATIC IN THIS SECTION FOR PROPER CONNECTOR AND PIN ORIENTATION.

STOP-WARNING

You should enter this Pinpoint Test only when directed here from Quick Test Step 3.0, 5.0 or 6.0 or when directed here from Diagnostics by Symptom in the Engine Supplement Section or from a Pinpoint Test Step.

This Pinpoint Test is intended to diagnose only the following:

- Processor.
- Harness Circuits: Signal Return, STO, STI, Ground, VPWR, KAM, VREF, Ignition, NDS, EEC Power Relay.

No Codes/Codes Not Listed | Pinpoint Test | Q

TEST STEP	RESULT ▶	ACTION TO TAKE
Q1 NO CODES, CODES NOT LISTED		
Refer to illustration Q. • Key Off, wait 10 seconds. • DVOM on 20V scale. • Disconnect TP sensor. • Key On, Engine Off. • Measure voltage between VREF at the TP harness connector and signal return in Self-Test connector.	Less than 4.0V or greater than 6.0V ▶ 4.0V to 6.0V ▶	GO to Pinpoint Test Step C1. RECONNECT TP sensor. GO to Q2.
Q2 SELF-TEST INPUT CONTINUITY CHECK		
Refer to illustration Q. • Key Off, wait 10 seconds. • Disconnect processor 60 Pin connector and inspect for damaged pins, corrosion, loose wires. Service as necessary. • Install Breakout box, leave processor disconnected. • Set DVOM to 200 ohm scale. • Measure resistance between Self-Test input at the Self-Test single pin connector and test Pin 48 at the Breakout box.	Less than 5 ohms ▶ 5 ohms or greater ▶	GO to Q3. CORRECT open in circuit.
Q3 SELF-TEST OUTPUT CIRCUIT CONTINUITY CHECK		
Refer to illustration Q. • Breakout box installed. • DVOM to 200 ohm scale. • Measure resistance between Self-Test output at the Self-Test connector and test Pin 17 at the Breakout box.	5 ohms or greater ▶ Less than 5 ohms ▶	CORRECT open in circuit. GO to Q4.
Q4 EGO SENSOR GROUND CONTINUITY CHECK		
Refer to illustration Q. • Breakout box installed. • Key Off. • Measure resistance between EGO ground on engine and test Pin 49 at the Breakout box.	Less than 5 ohms ▶ 5 ohms or greater ▶	GO to Q5. CHECK and SERVICE EGO sensor ground wire or open circuit bad connection.

No Codes/Codes Not Listed	Pinpoint Test	Q

TEST STEP	RESULT ▶	ACTION TO TAKE
Q5 STO SHORT TO GROUND • Breakout box installed. • DVOM on 200 ohm scale. • Measure resistance between Self-Test output at Self-Test connector and engine block ground. • Is resistance greater than 5 ohms?	Yes ▶ No ▶	REPLACE processor. RERUN Quick Test. GO to Q8.
Q6 HEGO HARNESS SHORT TO POWER • Key Off. • Breakout box installed, leave processor disconnected. • Disconnect HEGO. • Measure resistance between test Pin 29 and test Pins 37 and 57 at the Breakout box. • Is reading less than 10,000 ohms?	No ▶ Yes ▶	SERVICE harness short to power. RERUN Quick Test. GO to Q7.
Q7 HEGO SHORT TO POWER • Key Off. • HEGO disconnected. • Measure resistance between RUN circuit and EGO circuit on the HEGO connector. • Is reading less than 10,000 ohms? **NOTE: Refer to HA for connector orientation.**	Yes ▶ No ▶	REPLACE HEGO. RERUN Quick Test. GO to Q8.
Q8 INTERMITTENT NDS • Key Off. • Breakout box installed. • Connect DVOM between test Pin 30 and test Pin 40 or 60 at the Breakout box. • Key On, engine running Self-Test. • Is voltage greater than 1V? **NOTE: Refer to FA for connector orientation.**	Yes ▶ No ▶	SERVICE intermittent in NDS harness, connector or switch. If OK, GO to Quick Test Step 5.0 for appropriate service codes. SERVICE intermittent in NDS harness, connector, or switch. If OK, GO to Q9.

No Codes/Codes Not Listed	Pinpoint Test	Q

TEST STEP	RESULT ▶	ACTION TO TAKE
Q9 POWER RELAY ALWAYS ON		
• Key Off. • Breakout box installed. • Connect DVOM to test Pin 37 or 57 and to test Pin 40 or 60 at the Breakout box. • Turn key on and off. Wait 10 seconds. • Does voltage change from 10.5V or greater to zero volts?	Yes ▶	GO to **Q9A**.
	No ▶	REPLACE EEC Power Relay or integrated Relay Controller. RERUN Quick Test.

Continuous Test Code 15 — Pinpoint Test Q

TEST STEP	RESULT ▶	ACTION TO TAKE
Q10 CONDITIONS FOR CONTINUOUS CODE 15		
• Power interruption to Keep Alive Memory (KAM) Pin 1 may result in a service code being outputted.* • Clear continuous memory codes (use procedure described in Quick Test Step 6). • Repeat Quick Test Step 3.0 through Continuous memory code output. • Code 15 present on retest? ***NOTE: Anytime power is interrupted to the processor, a code 15 may be outputted the first time Self-Test is run after restoration of power. Repeat Self-Test to ensure correct diagnosis.**	Yes ▶ No ▶	GO to **Q11**. Test complete.
Q11 INSPECT ENGINE COMPARTMENT WIRING FOR PROPER ROUTING		
• Are any EEC components or EEC wiring close to ignition components or wires (High Electrical Energy Sources)? If EEC wiring close, reroute and rerun Self-Test. • Is code 15 still present?	Yes ▶ No ▶	GO to **Q12**. Test complete.
Q12 CHECK POWER CIRCUIT TO KEEP ALIVE MEMORY		
• Key Off, wait 10 seconds. • Disconnect processor and inspect both 60 Pin connectors. • Connect Breakout box to harness, leave processor disconnected. • DVOM on 20V scale. • Connect positive test lead to test Pin 1 and negative test lead to test Pin 40 or 60 at the Breakout box. • Key On. • Observe voltage reading.	Reading less than 10V ▶ Reading 10V or greater ▶	SERVICE open to KAM circuit. RERUN Quick Test. REPLACE processor. RERUN Quick Test.

Engine Stalls During Quick Test | Pinpoint Test | Q

TEST STEP	RESULT ▶	ACTION TO TAKE
Q30 DIAGNOSTIC ROUTINES COMPLETE		
• Have diagnostic routines in Section 2 been completed?	Yes ▶	GO to **Q31**.
	No ▶	GO to Diagnostic Routines, Section 2.
Q31 ATTEMPT TO BRING ENGINE TO OPERATING TEMPERATURE		
• Key Off, wait 10 seconds. • Install tachometer. • Try to maintain engine at 2,000 rpm for 2 minutes. • Can rpm be maintained?	Yes ▶	GO to Pinpoint Test Step **A13**.
	No ▶	GO to **Q32**.
Q32 MAINTAIN ENGINE OPERATION DURING ENGINE RUNNING QUICK TEST		
• Engine at operating temperature. • Tachometer installed. • Key Off, wait 10 seconds. • Activate Quick Test. • Perform Engine Running Self-Test while maintaining 2,000 rpm.	Code 11 ▶	GO to Quick Test Step **5.0**.
	Any service code ▶	GO to Quick Test Step **5.0B**.
	No codes ▶	GO to Pinpoint Test Step **Q1**.

Output State Check Not Functioning — Pinpoint Test Q

TEST STEP	RESULT ▶	ACTION TO TAKE
Q40 CHECK FOR CODES 23, 53, 63 OR 68		
• Key Off, wait 10 seconds. • Perform Key On, Engine Off Self-Test. • Leave Key On to enter Output State Check. • Key On, Engine Off. Are codes 23, 53, 63 or 68 present?	Yes ▶	GO to Quick Test Step **3.0B** and SERVICE appropriate code as instructed.
	Code 11 ▶	GO to **Q41**.
	No Codes ▶	GO to **Q1**.
Q41 CHECK THROTTLE LINKAGE		
• Check throttle and throttle linkages for sticking and binding. • Throttle OK?	Yes ▶	SERVICE as necessary. RERUN Quick Test.
	No ▶	REPLACE TP sensor. RERUN Quick Test.

Processor Power Check | Pinpoint Test | Q

TEST STEP	RESULT ▶	ACTION TO TAKE
Q50 CHECK FOR POWER TO PROCESSOR		
• Key Off, wait 10 seconds. • Disconnect processor 60 Pin connector and inspect for damaged pins, corrosion, loose wires. Service as necessary. • Install Breakout box. • Key On, Engine Off. • DVOM on 20V scale. • Measure voltage between test Pin 37 and test Pin 40 at the Breakout box and between test Pin 57 and test Pin 60 at the Breakout box.	Either voltage reading less than 10.5V ▶	GO to Pin-point Test **B-1**.
	Both voltage readings 10.5V or greater ▶	REPLACE processor. RERUN Quick Test.

Erratic Ignition | Pinpoint Test | Y

TEST STEP	RESULT ▶	ACTION TO TAKE
Y1 CODE 14: ERRATIC IGNITION **NOTE: Code 14 indicates two successive erratic profile ignition pickup (PIP) pulses occurred, resulting in a possible engine miss or stall.** • Check EEC-IV and ignition systems harnesses for: — Loose wires/connectors. — Arcing secondary ignition components (coil, cap, rotor, wires, plugs, etc.). — On-board transmitter (2-way radio).* • Are any of the above present? *Verify all 2-way radio installations. Carefully follow manufacturer's installation instructions regarding the routing of antenna and power leads.	Yes ▶ No ▶	SERVICE as necessary. RERUN Quick Test. GO to Y2.
Y2 CHECK DISTRIBUTOR • Key Off, wait 10 seconds. • Deactivate Self-Test. • Connect VOM or STAR per Quick Test Step 2.0. • Enter Engine Running Continuous Monitor Test (as instructed in Quick Test Step 6.3). • Observe VOM or STAR LED for indication of a fault while performing the following: • Lightly tap on TFI module and distributor. • Wiggle TFI connector. • Is a fault indicated?	Yes ▶ No ▶	DISCONNECT and INSPECT connectors. If connector and terminals are good, GO to Group 23, Ignition System. GO to Y3.
Y3 CHECK EEC-IV HARNESS • While still in Continuous Monitor Test from Step Y2 observe VOM or STAR LED for a fault indication while performing the following: • While looking for faults grasp the harness close to the TFI connector. Wiggle, shake or bend a small section of the ignition and EEC-IV systems harness while working your way to the other components and dash panel. Also wiggle, shake or bend the EEC-IV harness from the dash panel to the processor. Isolate the PIP circuit if needed for this test. • Is a fault indicated?	Yes ▶ No ▶	ISOLATE fault and SERVICE as necessary. RERUN Quick Test. GO to Y4.

Erratic Ignition	Pinpoint Test	Y

TEST STEP		RESULT ▶	ACTION TO TAKE
Y4	CHECK PROCESSOR AND HARNESS CONNECTORS		
• Key Off, wait 10 seconds. • Disconnect processor 60 Pin connector and inspect for damaged pins, corrosion, loose wires. • Are connectors and terminals OK? • Reconnect processor when this Step is completed.		No ▶	SERVICE as necessary. RERUN Quick Test.
		Yes ▶	Unable to duplicate an erratic ignition fault in the EEC-IV System, for further diagnosis, GO to Group 23, Ignition System

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GLOSSARY

A/C Clutch Compressor Signal (ACC): A signal generated whenever the A/C clutch is turned on. The processor initiates compensation by increasing the engine idle speed through adjustment of the idle speed control.

Altitude Compensating Modulator: Device to control transmission shift spacing and engine timing. Improves performance at higher altitudes by changing the vacuum signals.

Ambient Temperature: Temperature of air surrounding an object.

Analog Volt-Ohm-Meter (VOM): A multi-function meter which measures voltage and resistance. Measurements are made with a d'arsenual meter movement instead of a digital display.

Automotive Emissions: Gaseous and particulate compounds that are emitted from a car's crankcase, exhaust, carburetor, and fuel tank (hydro-carbons, nitrogen oxides, and carbon monoxide).

BHS (Bimetal Heat Sensor): A unit using a metallic part consisting of two layers with different metals, to sense temperature changes. The layers expand at different rates as temperature changes cause the part to bend in a predetermined manner, thereby causing a changing signal. The engine cooling fan coolant temperature switch is this type of sensor.

BP (Barometric Pressure): A sensor or its signal circuit that sends a varying frequency signal to the processor relating actual barometric pressure.

B/P (Integral Backpressure EGR Valve): The integral backpressure EGR valve combines a ported EGR valve, a flow control orifice and control pressure transducer in one EGR valve assembly which controls EGR flow.

Canister: A container in an evaporative emission control system that contains charcoal to trap vapors from the fuel system.

Catalyst: A muffler-like device located in the exhaust system where hot exhaust gas comes in contact with special metals (i.e., platinum or palladium) that promote more complete combustion of unburned hydrocarbons and reduction of carbon monoxide.

Check Valve: A one-way valve which allows a liquid or gas to flow in one direction only—prevents backflow.

CO (Carbon Monoxide): A colorless, odorless gas that is a by-product of incomplete combustion of carbon. This gas is poisonous in confined spaces when it is at high concentration.

COC (Conventional Oxidation Catalyst): Acts on two of the major pollutants: HC and CO.

Computed Timing: The relationship of spark plug firing to crankshaft position expressed in crankshaft degrees. On EEC IV this function is controlled by the Profile Ignition Pickup (PIP) sensor.

Continuous Codes: Service codes stored in the processor's Keep Alive Memory (KAM) as a result of a failure (open or short), either intermittent or constant, detected in one of the sensor circuits (i.e., sensor-harness-processor). Codes are outputted only during Key On/Engine Off test.

Continuous Monitor: An aid in diagnosing intermittent failures in the sensor input circuits. Monitor is activated in either Key On/Engine Off or Engine Running modes.

CV: Control Valve.

Decel Fuel Shutoff (DFS): A gas-saving method when rpm is above 1800 and the throttle plate is closed. On injected engines, the injector "on time" is controlled by the processor regulating the amount of fuel introduced into the cylinder.

DVOM (Digital Volt-Ohm Meter): A meter which measures voltage and resistance and displays it in digital form on a liquid crystal display (LCD).

Dynamic Response Test: A Key On/Engine Running test in which a rapid acceleration is ap-

Dynamic Response Test (Continued) plied to the engine and the engine is checked for appropriate throttle movement, change in rpm and change in the intake air flow.

ECA (Electronic Control Assembly): Refer to Processor.

ECT (Engine Coolant Temperature Sensor): Refers to thermistor sensor or its signal line. Sensor is immersed in engine coolant fluid. Provides engine coolant temperature information which is used to alter spark advance and EGR flow during warm-up or overheat conditions (replaces cooling and EGR PVS).

EEC (Electronic Engine Control): A computer-directed system of engine control.

EESS (Evaporative Emission Shed System): A system for containment of evaporative fuel vapors introduced in 1978. Annual improvements have modified this system.

EFI (Electronic Fuel Injection): A system of computer-controlled multi-point direct fuel injection into the intake ports.

EGO (Exhaust Gas Oxygen Sensor): Exhaust Gas Oxygen Sensor or its signal line. Sensor changes its output voltage as exhaust gas oxygen content changes when compared to oxygen content of atmosphere. Constantly changing voltage signal is sent to the processor for analysis and adjustment of the A/F ratio.

EGOR (EGO Signal Return): EGO signal return with separate ground on engine block.

EGR (Exhaust Gas Recirculation): A procedure where a small amount of exhaust gas is readmitted to the combustion chamber to reduce peak combustion temperatures and thus reduce NO_x emissions.

EGRC (EGR Control Solenoid): Electrical solenoid or its control line. Solenoid switches engine manifold vacuum to operate EGR valve. Vacuum opens EGR valve when solenoid is energized.

Engine Running Test: A section of the EEC IV and MCU self test, that tests the inputs and controlled functions under actual operating conditions. The actuators are exercised and checked for corresponding results.

EPA (Environmental Protection Agency): Federal agency having responsibility for administrating congressional programs relating to the protection of the environment.

EVR (EGR Valve Regulator): A processor output used to regulate EGR vacuum to the EGR valve.

Exhaust Gas Analyzer: An instrument for determining the amount of HC and CO emitted to the atmosphere. These instruments usually incorporate a "wheatstone bridge" to analyze the thermal conductivity of the mixture. A means of determining the efficiency with which the engine is then burning fuel.

FP (Fuel Pump Relay): Relay or its control line. Relay is controlled by the processor. Supplies power to electric fuel pump or EFI/CFI system.

Fuel-Rich, Lean: A qualitative evaluation of air/fuel ratio based on the voltage from the exhaust gas oxygen (EGO) sensor. If there is an excess of oxygen (EGO voltage < .4 volt) the mixture is said to be "lean" and if there is insufficient oxygen (EGO voltage > .6 volt) the mixture is said to be "rich."

GND (or) Ground: Common line for all vehicle power, vehicle chassis ground and engine block ground, connected to vehicle battery negative terminal.

HC (Hydrocarbon): Any compound composed of carbon and hydrogen, such as petroleum products. Excessive amounts in the atmosphere are considered undesirable contaminants and a major contributor to air pollution.

Identification Code: A single-digit, self-test service code, outputted at the beginning of the Engine Running test which is equal to one-half of the number of engine cylinders.

Idle Speed Control (ISC): An actuator mounted to the fuel charging assembly which controls the idle speed. The ISC functions as high cam rpm, anti-diesel shutoff, dash pot and prepositioning for next vehicle start.

Ignition Diagnostic Monitor (IDM): A continuous self-test feature which senses a fault in the TFI IV Ignition Module Coil output signal.

Inertia Switch: A switch in the fuel pump circuit which shuts off power to the fuel pump in the

Inertia Switch (Continued)

event the vehicle is involved in a collision. This switch must be manually reset.

Injector: EFI/CFI system electrical solenoid or its control line. Solenoid, when energized, allows fuel flow into the intake track where it is mixed with air for combustion.

Knock Sensor (KNK): A piegoelectric accelerometer designed to resonate at approximately the same frequency as the engine knock frequency and provide this information to the processor.

Light-Emitting Diode (LED): A p-n junction of crystal material, housed in a dome-shaped housing, which produces light when forward bias current is applied.

Mass Air Flow Meter (MAF): A sensor that measures the mass of air flowing through the meter via a hot wire sensing element and an electronic circuit.

MAP (Manifold Absolute Pressure): A sensor or its signal circuit that sends a varying frequency signal to the processor for calculation of barometric pressure based on manifold vacuum and manifold pressure.

Monolithic Substrate: The ceramic honeycomb structure used as a base to be coated with a metallic catalyst material for use in the converter.

NO_X (Nitrous Oxides): A compound formed during the engine's combustion process when oxygen in the air combines with nitrogen in the air to form the nitrogen oxides which are agents in photochemical smog.

On Demand Test: In self test, the Key On/Engine Off and Engine Running positions which are technician-initiated and are run from a program within the processor.

Open Circuit: A circuit which does not provide a complete path for the flow of current (no continuity).

Output Cycling Check (OCC): A position of the end of the Key On/Engine Off test that enables energizing and de-energizing the auxiliary output on demand.

Output State Check: A test performed in the Key On/Engine Off mode after the continuous codes have been sent which forces the processor to activate some actuators for additional diagnostics.

PCV (Positive Crankcase Ventilation): A system which controls the flow of vapors from the crankcase into the engine intake system where they are burned in the engine cylinders rather than being discharged unburned into the air from the crankcase.

Potentiometer (POT): A variable resistor with three connections. The third connection (wiper) moves physically up and down the resistive element which has each end attached to one of the other two connections.

Profile Ignition Pickup (PIP): A "hall effect" vane switch sensor furnishes crankshaft position information to the processor. Replaces the crankshaft position sensor in EEC IV applications.

Processor: The "on board" computer that receives data from a number of sensors and other electronic components. Based on the input data and information programmed in the processor's memory, the processor generates output signals to control various engine functions.

Quick Test: A functional diagnostic test of the EEC system consisting of Key On/Engine Off, Engine Running and Continuous tests and vehicle preparation and hookup. Results are displayed as a series of service codes.

Ratio: The proportion of value divided by another.

Relay: A switching device operated by a low current circuit, which controls the opening and closing of another circuit of higher current capacity.

Self Test: A part of the functional Quick Test diagnostic procedure which verifies that sensors and actuators are connected and operating properly. Key On/Engine Off and Engine Running detect hard faults while the ongoing Continuous test stores intermittent fault information for later retrieval.

Self-test Input (STI): The circuit in EEC systems which is used to initiate self test. (In EEC IV,

Self-test Input (STI)(Continued)
jumper pin 5 of the self test connector to the single-spaded gray connector.)

Self-test Output (STO): The circuit in the processor which transmits the service code to either a VOM or STAR tester for display.

Separator Pulses: A pulsed code consisting of a single one-half second pulse between the last service code and the first continuous code of self test.

Service Codes: A series of two-digit numbers representing the results of self test. The EEC IV communicates this service information via the self test output connector as a series of timed pulses read either on a VOM or a STAR tester.

SHED (Sealed Housing Evaporative Determination System): See EESS.

Solenoid: A wire coil with a movable core which changes position by means of electromagnetism when current flows through the coil.

SOL V: EGR Solenoid Vacuum Valve Assembly.

Spark Output (Spout): The output signal from the processor which triggers the TFI-IV Module to fire the ignition coil.

SIG RTN or SRTN (Signal Return Line): A return line for all sensor signals except EGO.

STAR Tester: An automatic readout device which displays self-test service code and continuous codes in digital format. This tester connects to the EEC IV's self-test output connector.

Thermistor: A resistor that changes its resistance with temperature.

Timing: Relationship between spark plug firing and piston position, usually expressed in crankshaft degrees before or after Top Dead Center (TDC) of compression stroke. Example: 15 degrees BTDC.

TP (Throttle Position Sensor): Potentiometric sensor or its signal line. Sensor wiper position is proportional to throttle position. Defines engine operation mode: closed, part or wide open throttle.

Transducer: An electrically actuated vacuum regulator.

Turbo Boost Actuator (BOOST): An output of the processor which ensures that no boost will be applied until certain engine conditions have been met.

TWC (Three Way Catalyst): Sometimes referred to as a dual catalytic converter. Combines two converters in one shell. Controls NO_X, HC and CO.

Vacuum: A term used to describe a pressure that is less than atmospheric pressure.

Vane Air Flow Meter (VAF): A sensor with a movable vane connected to a potentiometer calibrated to measure the amount of air flowing through the sensor. The output signal is relayed to the processor which then translates the information into the amount of air flowing into the engine.

Vane Air Temperature (VAT): A sensor located in the vane airflow meter which senses the temperature of the air flowing into the engine. Changes of temperature result in changes in a resistive element in the sensor.

Vane Meter (VM): See Vane Airflow Meter.

VBAT: Vehicle battery voltage.

VCV (Vacuum Check Valve): Used to retain vacuum signal in system after vacuum source is gone.

VECI (Vehicle Emission Control Information Decal): Critical specifications for servicing emission systems. Decal located in engine compartment.

Volt-Ohm-Meter: See AVOM, DVOM.

VREF (Reference Voltage): Power supplied by ECA to some sensors regulated at a specific voltage (8 to 10 volts EEC-1, 2, 3 and 4 to 6 volts EEC-IV).

VRESER: Vacuum Reservoir.

VREST: Vacuum Restrictor.

VR/S: Vacuum Regulator/Solenoid.

Wiper: Refer to Potentiometer.

WOT (Wide Open Throttle Valve): In some EGR applications, it is desirable to cut off EGR flow at wide open throttle, where a richer fuel mixture is needed for performance. Valve is vacuum-actuated when "full throttle" signal is received from the carburetor.

Wide Open Throttle A/C Cutoff (WAC): A switch that is actuated during A/C operation when WOT acceleration is sensed. This switch turns off the A/C compressor for a short period until stabilized PT is achieved. The A/C remains off for approximately three seconds after returning to part throttle.

ORDERING SPECIAL SERVICE TOOLS

Special service tools, as designated in this manual, are easy to order and you will receive prompt shipment to assist you in servicing the vehicle.

In U.S.A., to order tools simply contact Owatonna Tools, Inc., by mail, telex or phone.

If you wish to order by mail, send your order with your complete address to Owatonna Tools, Inc., Owatonna, Minnesota 55060. Order forms are available upon request.

If you wish to use their Telex, the number is 29-0876.

If you would like to call, the phone number is 507-455-2626. Ask for the Ford Order Desk.

The telephone order desk is open 24 hours every day to provide you with immediate response to your "special tool" requirements.

Customer Special Service is available for the unusual situations.

A. Emergency orders. In these cases call and place your order. Please specify that you do have an emergency order. Shipment will be made the same day if at all possible.

B. If you require information regarding tracing, order follow-ups, pricing information or assistance in any way, please call or write.

State and local sales taxes will be added to the invoice if applicable.

All tool shipments will be made F.O.B. Owatonna, Minnesota. Shipments will be made by any method specified. Normal methods include United Parcel Service or Parcel Post.

In Canada, Special Service Tools are available from Jobborn Manufacturing (1979) Ltd. . . . 97 Frid St., Hamilton, Ontario L8P 4M3, 416-522-2580.